

July 2, 1956

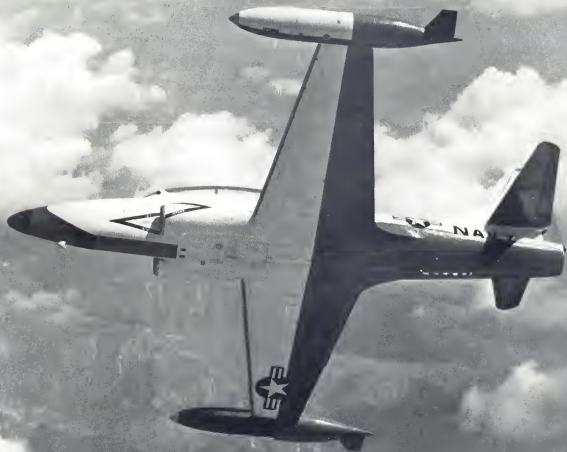
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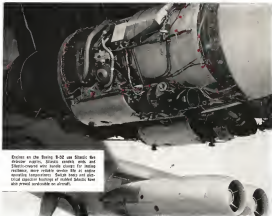
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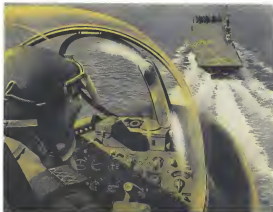
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JULY 5, 1956

## AVIATION WEEK

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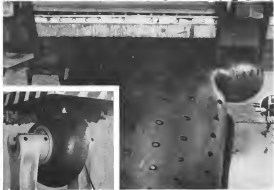
CONVEY— Lockheed T28 1 Section on evolution of the T28 design. Application of the principle of performance. Former for New series may have boundary layer control and leading edge lift for increased low speed stability. Redesigning empowers greater greater stability over other aircraft. Landing speed as a result is not 4 km. takeoff speed 7 km. and pattern speed 175. Photograph in Aviation 11-121 containing data on light color at 1,000 ft. dep.

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## EDITORIAL

### Avionics Reliability vs. USAF Capability

(The Air Force this month will accept delivery of a new piece of avionics equipment, the first of its type to become ready for operational use. Its development was begun in 1945. Coupled with the need for better reliability, the slow development cycle of avionics gear poses a problem of the first magnitude and presents a threat to our weapon capability. This problem was discussed by Maj Gen Thomas P. Gerth, USAF assistant for production programming, in a recent address before the Electronics Association, Aviation Week in presenting significant extracts because of its interest to the entire aviation industry.)

Tremendous advances have been made during the past decade in weapon systems utilized by the Air Force for the performance of our mission, and of particular interest . . . is the increased use of electronic equipment in our weapons. This use, which has exponentially increased our capability in terms of supersonic speeds, has grown steadily over the past few years . . .

#### Reliability Failures

Inherent in any growth of this nature are many problems which the industry and the Air Force must solve if we are to release our utilization of the electronic equipment. The major problems presently being encountered are: Lack of adequate specifications caused by late development, failure to meet production schedules and, most important of all, failure to achieve satisfactory reliability.

Development time tables have not always been met. For example, of the total amount proposed for Fiscal 1955, only 73% was obligated as of 31 March, 1956, some months after the end of the fiscal year, possibly because of delays in development. The impact of these engineering and development difficulties is also reflected in our production record for calendar year 1955 during which deliveries of major electronic equipment were only 80% of the dollar value of scheduled production.

These delays have disrupted our progress in achieving a balanced capability in our air and ground environment. In addition, as a result of these delays, we have not been able to carry out planned procurement programs. Therefore, our current programs are being discounted until we have demonstrated a capability of meeting desired production goals.

Another problem is reliability. During its tenure of duty as a tactical command from 1950 to 1955, the vast majority of mission alerts were caused by failure of the electronic gear incorporated in the various systems such as bombing, navigation, fire control and communications.

The evolution of the jet engine has given us greater speeds, more reliability and reduced the maintenance workload over that previously required for the reciprocating engine. Conversely, electronic equipment has increased the maintenance workload tremendously by virtue of our failure to achieve the necessary reliability.

This problem is further aggravated by the large turnover of military personnel who maintain our electronic equipment. It is currently estimated that 45% of our skilled electronic personnel will leave military service during the next two years. For the Air Force has not been able to compete with the salaries and benefits offered by industry.

The weapon system concept and other Air Force policies emphasize the added responsibility that we are placing in the hands of industry. One example that I might cite is our spare parts provisioning.

The Air Force includes in its basic contract, information relative to the planned utilization, such as program flying or operating hours, maintenance, pre-positioning or lot requirements. The contractor is given the responsibility to select the spares and select them for production without prior approval of the Air Force. The costs of cancellations resulting from subsequent nonapproval by the Air Force of the contractor's schedule in the provisioning items are borne by the government. Our experience to date shows that the costs of cancellations have been significant, whereas this authority has contributed appreciably to the attainment of adequate and concurrent support.

#### Industry Challenges

I think this procedure demonstrates our feeling that industry has, or must be expected to develop a capability to analyze properly the proposed utilization of a piece of equipment and measure the range of spares required.

As I see it, the electronic industry faces some very important challenges today. These are:

- Much greater gains must be made in simplicity and reliability of electronic systems.
- We must achieve a closer adherence to our development production schedules.
- Increasing management responsibility placed in industry requires that Air Force-industry relations reach a new high in mutual understanding and team work. Only through a maximum increase of our joint efforts can we reach the goals vital to our national interests.

Our increasing reliance on electronics in the future will be greatly influenced by the ability of industry to meet these challenges.

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## WHO'S WHERE

### In the Front Office

Henry F. McKenney, vice president engineering, Lockheed Corporation of Aircraft, Culver City, Calif.

Dr. W. R. G. Eiler, consultant to a variety of our products/contract, Ames and Deane, Science Group, General Electric, Syracuse, N. Y. Dr. Belin is a GE vice president.

Clinton Dine, assistant to the president, Science Research, Ames.

Frank J. Marshall, vice president general manager, West Coast branch, Science Corp., San Redford, Calif. Also Robert A. Haglund, vice president manufacturing.

John Larkin, vice president engineering, Lucas Industries, industrial division, in the product.

Charles S. Allen, Jr., president, Aerospace Division, Inc., Dallas, Calif., and Edmond E. Wood, vice president.

M. H. Carlson, Stuart N. Smith and George B. Smith, vice president, General Corp., North Division, Dallas, N. Y.

Ray Geo. Ott, D. Roman, Jr., vice president, USAF School of Aviation Medicine, Fort Belvoir, Tex.

Kabert J. Smith, vice president sales and public, Lockheed, Tex.

### Honors and Elections

Paul Hartz, chief weights engineer, Republic Aircraft Corp., Glendale, N. Y., received a Fellowship from the National Society of Aeronautical Engineers.

J. Edward Gough, National Advisory Committee for Aeronautics, received nomination to fill the James Clark Maxwell professorship at Massachusetts Institute of Technology for one year.

Joseph A. Strick, executive pilot for Lockheed, received the 1964 Best Pilot Award from the National Aeronautics Association.

D. T. Williams, president, Williams Research & Development Co., Cleveland, Ohio, is elected president of the Magnetics Association.

### Changes

Joseph F. Newman, manager, North American Division, North American Aviation Inc., Van Nuys, Calif.

H. R. Seal, in charge of experimental vehicle systems, Directorate of Aeronautical Research and Development Laboratory, Hughes Aircraft Co., Culver City, Calif.

Walter V. Smith, general manager, Republic Division (Aircraft), N. Y. Let's go, Republic.

Vincent Mullen, chief product engineer, Ford & Foster Co., Baltimore, Md.

Don C. Smith, operations manager, Aircraft Transport, San Francisco, D. C. and John I. Kennedy, general manager, Republic.

Jack E. Smith, manager, service department, General Electric Tool Co., Cleveland, Ohio.

Franklin M. Spangler, manager, sales division, Texas World Airlines.

## INDUSTRY OBSERVER

More than 12 earth satellites may be placed in the U. S. air launching during the International Geophysical Year. Latest Navy contracts add five or more as 75 of some comparison for the satellite and its vehicle (see editorial page on satellites and launch vehicles)—an outgrowth.

Fabrication of flexible cyclotron of 6000 is, various said to be in progress by Cambridge Corp. Working methods developed by Cambridge could be applied in fabrication of a 5 ft. diameter static balloon such as that suggested for the recovery of data from an earth satellite (AIEE May 24, p. 51). Cambridge also suggests that aerodynamic heating could be utilized to separate water with resulting steam entering the balloon. This could eliminate the need for a helium container in the satellite package and would provide cooling for the balloon on reentry to the earth's upper atmosphere.

Defense Department estimates that under the present B-52 program, the Air Force will have 180 of the Boeing Stratofortresses by October 1970.

Air Research and Development Command has awarded the Consolidated Electronics Corp., Pasadena, Calif., a \$1.2 million contract to provide magnetic tape instrumentation along the USAF's planned 5000-mile transatlantic route which will extend from Florida across the Atlantic to Antarctica island off the African coast.

Lock is conducting tests and means of firing guided artillery missiles from helicopter platforms.

Arco Corp. of Englewood will construct a laboratory for research into traffic noise contributions at White Sands, N. M.

Air Materiel Command has awarded Lockheed Aircraft a \$1 million replacement program contract for a reconnaissance version of the F-104.

Lt. Gen. James M. Gurnea, Army chief of research and development, has announced reports that the Soviet Union has "freed an object that must have been a rocket for several hundreds of miles in some manner."

Prestige reportedly tested down a request by the U. S. Air Force to Europe for its own set of Douglas C-124 transports. The Pentagon says C-124s would be used only within the U. S. to carry out global missions.

Magnetic evaporation and ionization systems will be offered shortly by Sperry Gyroscope. The "ultra-light" weight unit will have sensitive sensors adjustable for all heat settings to over 1,000 degrees and can be used in any location on planet or jet aircraft.

McDonnell's F-101A has been flown at a maximum gross weight of 40,000 lb. during its flight test program at Edwards AFB.

Germans have created the largest rotating mass in a helicopter engine as being 10% accuracy for the first time in West's reduced-inertia-rotating X-11 because of the relatively heavy rotating mass in comparison with the turbine's enormous light inertia.

Science SB-210 Corvair has flown Algeria to Paris in three hours, 13 minutes on one of its coasting trials for Air France. Powered by two Rolls-Royce Avon jet engines, the Corvair has taken off within 6,000 ft. on one engine with an all-up weight of 72,980 lb.

Arco aviation is expanding fast in Europe, will soon have its own supply depots located at strategic points.

Highest current efficiency for the conversion of solar energy is running at about 17% using semi-conductors as a solar battery. Application to aircraft as power source appears distant but possible ground uses in areas of little or no cloud cover may not be too far away.

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It doesn't look easy to develop the Dragonfly's many faceted eye. Today, at Kollman, highly complex optical systems such as photoelectric trackers, periscopic systems, telescopes for radar bombing systems, and others, are not only designed expeditiously, but are produced in quantity.

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## Chinese Rockets and Murphree

An example of the seriousness with which the Pentagon strengthens its defense posture was exhibited in a speech written for Egar V. Murphree, Defense Secretary, Wilson's special assistant for guided missiles, for delivery before the American Rocket Society's annual meeting.

Murphree's first public address in his new position made before a society whose membership is made up of professional scientists and engineers working in the body of jet propulsion, rockets and guided missiles, an unusual length of an elementary presentation of the history and development of rockets, drawn for the most part from the Encyclopedia Britannica. Approximately one-fifth of the speech was devoted to the historical background of guided missiles, beginning with Chinese rockets of the thirteenth century. The remainder was an elementary presentation on different types of guidance and propulsion systems. Murphree concluded that guided missiles undoubtedly are complex.

The less complex American Rocket Society was simply perplexed.

## Wilson's Hot-Water Tea Party

Defense Secretary Charles E. Wilson, more noted as an understudy than as a man of his, hosted off for two days of Cautious looking last week, leaving Washington in an uproar for which he admittedly was largely to "blame."

Earlier during a three-day meeting of 160 defense leaders at nearby Quantico, Va., Wilson had attempted to double his feet into hot water.

• Denouncing an executive Republican proposal for a \$100 million increase in the USAF's fiscal 1957 budget after the measure apparently had passed the last approval of President Eisenhower (AW June 23, p. 26).

To make matters worse, the unceremoniously kept Secretary Wilson's "hot water" during a discussion of the merits of the Republican bill and the Democratic counter proposal for a \$110 million increase. Newsweek interrupted the word as being applied to both Republicans and Democrats efforts to increase the budget. Wilson later denied that it was directed at either, but a Senate source already had broken the page 30.

• Among a directive ordering all military officers in the Washington area to wear civilian clothes while on duty after July 1. Wilson's finding was that the military was too much in evidence in the nation's capital and would do better to disguise itself. Feeling as the Pentagon particularly among power rooms officers, was that the order represented a severe financial blow. (The order of most officers' civilian wardrobe is well-known sports wear.)

President Eisenhower agreed, and, one day after the original decision, Wilson modified his order to make the wearing of civilian clothes "optional."

• Denying that the Air Force has "plans of eyes to die (in) and that the Army can be made, under fire, with better eyes. Even when Secretary (Beverly) seemed surprised. In reply to a question over proposed eyes, Beverley said: "Nobody has taken it up with me yet."

He added that he feels "rather strong" that the present Army is about the right size.

This completed, and obviously feeling he had done enough, Wilson decided to call off a scheduled press conference on the last day of the Quantico meeting. He seemed distant, however, to one who even more trouble later in the week when he was to appear before Sen. Stuart Symington's Senate subcommittee investigating Sub Committee.

## Budget Cripples Missile Defense

Hardly had Secretary Wilson made his straight presentation that Gen. Thomas D. White, USAF vice chief of staff, named defense leaders at Quantico that "we have not made adequate progress toward developing a defense" against the intercontinental ballistic missile. Gen. White said the Soviet Union could have long-range missiles in 1955-56. In 1956-57, he added, "a coordinated effort to provide an effective missile defense is one of the most serious requirements in our national security." Under the USAF budget proposed by the Administration, 32 million had been allocated for the project and a direct defense against long-range ballistic missiles.

The Air Force originally had asked for \$24 million (AW June 23, p. 27).

## Wilson's R. S. V. P.

On yet another foot, Secretary Wilson declined an invitation to lunch, before the House Information Subcommittee on July 5 and assigned Robert Topp, his assistant secretary for legislative and public affairs, to appear in his stead. Wilson, however, can be in for a "crisis."

If the subcommittee, headed by Rep. John E. Moss (D-Calif.), next attacked with "hot" answers of will try again to get Wilson. It wants to question him on his answers regarding the recent firing of the intercontinental missile on its launch. Some time ago, regarding the philosophy of a former aide, R. Karl Hassman, that only "unreliable" military information should be released to the public.

Subcommittee also wants to question, Admiral Arthur Radford on his remark that the nation's press "confuses" our allies.

Also scheduled to be called are Defense Department research and development, public information, legal and intelligence representatives.

## Vis-a-Vis

At once across the Senate Airpower Investigating Subcommittee Chairman Sen. Stuart Symington (D-Md.) to meeting that testimony given during closed hearings points an even dollar picture of U. S. weapons that which has been disclosed. Republican Sen. James East (Pa.) maintains just as strongly that the closed nature testimony, describing "atomic" and "biological" developments, can cause the greatest confusion.

On another matter, Symington is thoroughly pleased with the security review of nuclear weapons being conducted by Adm. Arthur Dore. Symington says the principal reason for the sometimes long delay in the release of closed testimony is the small size of his own staff.

—Washington staff



the Beers were also. Budget flying is V formations of three each. Extensively, at least, they modeled life now.

Next came 50 Flaklight's streaking by in V formations of five planes each led by Col. Volk. The Flaklight, a Russian, came north this picture had indicated was a large, jet engine, but its tail thrust, indicates that aircraft may be Soviet three. The control line of the Flaklight is sharp except head, with the horizontal stabilizer mounted under up.

Following the Flaklight were 60 Farmers in echelon, left, flying in the 500 mph class, led by Lt. Col. Stepanov. The Farmer, powered by two axial flow engines believed to be of Soviet design, has a high-speed ratio, 60 degree sweptback wing and a large, round air intake for high-altitude performance.

The twin tailages of the Farmer are visible because it better than other descriptions but there is some doubt as to whether the Farmer is a double engine aircraft. The aircraft's horizontal tail is set low, just below the fuselage line, in contrast with the high tails of all other Soviet jet fighters seen.

The lighter formation of the Farmer at this point, says Tashkent were extremely tight and evidenced a high degree of pilot training.

#### Helicopter Assault

The finale of the show was a mass attack against Tashkent airfield in 50 Heland and four Heland helicopters carrying tanks, artillery, and troops.

It was less than eight minutes from the time the helicopters appeared on the horizon to the point where ground troops had set up the damaged equipment and were ready for action.

Later, as Heland pilots were seen through the air, ground troops were being carried that could be compared in quality with that of a crack rifle drill team.

The Heland, larger than a Sikorski H-35 and bearing a resemblance to the H-35, has two triangular horizontal stabilizers, engine back on the tail boom and carries an armament pod beneath the main cabin. The Heland, however, appeared unstable in the gusty winds.

#### Soviet Acrobatics

The military fly by was preceded by acrobatic demonstrations by 1000 soldiers in 1000 Y-15 and 1000 Y-15 in addition, pilots in Farmers and Freres.

One of the Farmers, flown by Lt. Col. Pavlov, displayed acrobatic tricks in the manner of U.S. stunt teams to mark its path during the aerial demonstration.

The best flying of the day came from

four Farmers commanded by Col. Solovov flying in a diamond formation.

However, its appearance was not as elaborate, nor its formation as precise, as that of either the USAF Skyraiders or the Navy's Blue Angels.

Another five o'clock demonstration in precision formation flying was performed

## Twining Visits Soviet Factories, Views Production of Nene Engine

Moscow—The Russian visit of Gen. Nathan F. Twining, USAF chief of staff and top air force official from 28 other countries, ended the first major week in the Iron Curtain that has marked the Red air force since even before World War II.

An official guide of the Soviet air force, the Twining party was permitted to visit two aircraft plants, later an operational military airfield, spend most of one day at the Zhukovskiy Air Engineering Academy and mingle with top Soviet political and military leaders at the Red Army Club reception given by Soviet Defense Minister Georgi K. Zhukov.

The group also toured Engine Plant No. 45 near Moscow where the Russian version of Britain's Nene jet engine has been produced since 1946.

The Soviets are now placing out production of the Nene as a jet and a shift to higher powered turbo-flow engines is well under way.

#### Russian Plans

Former design director told the Twining group that present production models of the Nene can produce a thrust of 5,000 lb. dry and 7,000 lb. with afterburner. Impressively the same as that of the Pratt & Whitney J57. The Nene or Kuznetsov engine as it is called here, is used to power the MiG-15 and 17.

#### Tu-104 to Canada?

Moscow—Russia is considering flying a Tu-104 four jet transport over the polar route to Toronto for the Canadian National Air Show which begins Sept. 3.

Edgar Anderson, president of the Royal Canadian Flying Club, here to consider applications for the flight, says only preliminary work has been done in the way of formal Soviet approval.

There also is a possibility that the Russian would accept an invitation to fly a Tu-104 to Oshkosh, Wis., for the National Airshow Show to be held over the Labor Day weekend.

by nine Russian flying in V echelons of three each with two larger V formations. These flights, however, demonstrated the most advanced to maintain the same formation while carrying out a series of acrobatics.

The only modern sighting of the Soviet jet, the demonstration of the Freres and an MiG-15.

In addition to China, Gen. Twining's group was escorted through the plant by manager Kuznetsov, who told Lt. Gen. Clarence S. Brown, USAF deputy chief of staff for material, that approximately 37% of the workers at the factory have been employed there for at least 10 years.

Machinists in the plant had been manufactured in a number of nations, including the U.S. and Germany.

At present, a total of 1,000 workers at the plant are engaged in production of the Nene.

Other parts of the factory, however, are engaged in the manufacture of farm machinery.

#### Dual-Purpose Plants

The ability to arm a dual purpose seems to be a characteristic of the older Russian aircraft factories with the one Soviet shifting to military and production in the military sphere.

Engine Plant 45 is where the original Russian Nene was developed and put into production after purchase of sample engines from the West.

At Zhukovskiy, Central Aircraft Plant No. 22 where Ilushin IL-10 transporters are manufactured, Gen. Twining reported that the IL-10 is being produced in both 15 and 16-foot versions and achieves an estimated cruise speed of 200 mph, on two 900-horsepower engines.

Soviet officials and Plant 10 is the chief aircraft plant in that country.

At Zhukovskiy the USAF officers were shown drawings of engines and airframes and supposedly experienced actual work. They also received a thorough briefing on the Soviet air engineering corporation.

#### No Military Production Seen

They did not see, however, any military aircraft production. Nor did they see any engines or such as the Tu-104 which powers the Bialys and Beas, nor large turboprops such as those used on the Bear and the new Anson helicopter.

After his visit to Zhukovskiy, Gen. Twining said the air engineering cor-

#### FAA Officials to Moscow

Moscow—Five American World Airways staff worked International Aerobics, Russia's state-owned airline, that its technical delegation a study in travel to Moscow for operating in the Soviet Union, pending approval by the U.S. airline into the Soviet capital. If successful, the delegation will be followed by top-level negotiations between officials of the two nations.

The technical delegation, headed by Harold Gray, Pan American's Aerobics Division chief, probably will fly to Russia sometime early this month. The proposed routes would carry Pan American into Moscow from Berlin and Helsinki.

even offered an extremely thorough course for the training of aeronautical engineers, one which the U.S. could not duplicate.

At Marshal Zhukovskiy's reception, top Soviet political leaders, including Communist party chief Nikita S. Khrushchev and Prime Minister Bulganin, and military leaders such as Marshal Sokolovskiy, Zhelezov and Bulganin mingled freely with the foreign guests, clapping enthusiastically, offering toasts and leaving in the night.

#### Twining's Answer

In response to Soviet boasts to discontinue and prevent information to the second Red news outbreak, Gen. Twining replied that the U.S. has no military ambitions and pointed out that it entered its last three major wars "late" and "unprepared."

He also noted that, after World War II, the U.S. stopped an military machine to the home as a "real democracy" and had to build up practically from scratch at the beginning of the fighting in Korea.

Now that the U.S. is strong again, Gen. Twining said, it will remain that way and other nations share their are prepared to accept a genuine disarmament such as the U.S. underwent after World War II.

The official reports of Gen. Twining and his party will be made to Defense Secretary Charles E. Wilson and President Eisenhower upon their return. There is no doubt, however, that they view the trip as being particularly valuable in establishing contact with Soviet air force leaders and in helping those in government the nation do displace as the Soviet air force.

There also is no doubt that the Soviets recognize the full implications of the air age and are pushing all out to take full advantage of it, not only in the military but also in the field of civil aviation.

BEINGS AT TASHKENT looked smaller than expected. The largest bomber is "slenderer" than Boeing's B-57 Superfortress.

seemed almost directly overhead and at low altitude.

For example, the Bear heavy bomber flew only at such a low altitude above us could not see the large operational number painted on its nose section.

The military fly by was led by a single Bear, piloted by Col. Kuznetsov and bearing the same number, 51. It was escorted by two Freres fighters flying at its wings to indicate comparative size.

#### 360,000-lb. Bear

The first, and strongest, impression at the maximum size of the Bear, which must have a gross weight of 360,000 lb. and a speed of 550 mph. Its high aspect-ratio wings radiate excellent high altitude performance, and each of its four turbo-prop engines develops the equivalent of 11,000 horsepower.

In the fly by, enormous engines and eight were clearly visible on the large subsonic nacelles which also house the leading gear. Tail-pipe exhausts for the turbo-prop were located on the underside of the nacelles.

Russian leaders doubtlessly placed the Bear at the lead place in the mili-

tary demonstration because of either USAF suspicion that the bomber is the Soviet's first intercontinental aircraft.

The initial Bear and its Freres escort were followed by a formation of three Bears bearing nose numbers in the 40s. These in turn, were trailed closely by three Beas.

#### The Bear

The Bear, smaller than its picture had indicated, is definitely smaller than Boeing's B-57 Superfortress. Following

#### Soviets Push Transports

Moscow—The Soviets are pushing hard to step up their production of aircraft. Writers observe in Moscow that the Tashkent air show noted a plant near Moscow where Ilushin IL-10 is offing of the line at a rate of 30 a month.

The plant employs 5,000 workers for a single shift operation and builds the complete aircraft—including instruments, nose and landing gear—except for the engines and electrical equipment.









### First KC-135 Nears Completion

From the fuselage of the second airplane, the first Boeing KC-135 multi-purpose jet transport-derivative for SAC, can be seen in its most complete at Boeing plant at Renton, Wash. Rollout of the transport will be scheduled for next month.

## News Digest

Oswald Engines Ltd., Toronto, announces it will offer its new jet engine, the P5-13, the lightweight engine of weighing 20,000 lb. Total, a power delta-wing CT-133 jet fighter was being built by Aero Aircraft Ltd. at Toronto for the USAF. USAF has bought a B-47 to RCAF to use as flying test bed for the engine engine.

A research, development and technical liaison facility has been established at Boston by the Aero-Venture Corp. of Los Angeles. The new facility is under the direction of George E. Jones, former chief engineer of the Laboratory for Electronics, Inc., also of Boston.

Airbus International secured the first of three Super-C Constellation scheduled for delivery in 1976 and 1977. The Airbus carrier's first now includes the Super Constellation and three Constellations.

A \$2 million contract for more than half of C-47 transports for the USAF has gone into work at Texas Aircraft Corp. at Commerce, Tex. Contract will continue through August, 1977. USAF also has contracted with Texaco for overhaul and wing changes in F-4G Republic Thunderbolt.

Compania Cubana de Aviacion, or Cuban Airline, has ordered 100 Vickers Viscount 800 turboprop aircraft for delivery at the end of 1974. New planes will supplement Cubana de Aviacion's initial fleet of three Viscount 700D's.

Japanese government approved two technical assistance contracts between Japanese and American firms. One is for introduction to Tokai-Gen Heavy Industries Co. of the manufacture of gas turbines for jet engines in the International General Electric Co. Other is license and technical assistance to the Sumitomo Metal Industry Co. by Cleveland Prototype Tool Co. for manufacture and sales of also shaft for F-800 and F-501.

A company specializing in testing aircraft to various civil airlines will be set up in Tokyo in early August. Sakura Co. Ltd. of Nagoya is forming the proposed 52.5 million Sakura Aviation Industry Co. Ltd. with the support of the Transportation Ministry. The new firm will purchase the Douglas DC-3 type planes from the Air Canada Service Corp. of Washington, D.C.

Members of the Council of the last week of the International Society voted during their meeting at Los Angeles to award a \$20,000 grant to establish a youth award for the individual contributing most during the year toward airplane design. David of the grant is announced. The youth award will be \$100.

Republic Aviation has received some \$15 million in new USAF contracts for spare parts production and maintenance of F-4E's. One contract of more than \$10 million is for a two-year maintenance program for each model F-4E to update them to current production models.

Aerobond Precision Corp. has produced 28% of stock of Motor Air

Transport, Inc., of Teaneck, N. J. Newhead President Fletcher Godwin and the stock purchase will provide Motor with additional working capital, much of it for new equipment.

Temporary laboratory has been leased by Case in San Diego to implement company's new basic research program. Dr. Charles L. Casfield, director of scientific research for Case air, and one of 25 to 30 scientists who eventually will make up the lab staff already has been hired.

Belgium contracted for a large number of Hawker Hunter fighters for its air force. The aircraft will be built and test flown by British Aerospace, Farnborough, and the Hawker Hunter, near Bristol. Rolls-Royce jet engines to power the aircraft are being built in Belgium for the European National Air Forces in Germany.

Multination dollar contracts for 30-lb. Men, 500-hp, jet engine gas turbines and P40-A 157 jet engine components have been awarded by Aero-Case Co. San Diego, Calif. The firm set a new delivery record for Men, shipping more than 57 million worth of business. As of April 10 the company's sales totaled \$10,441,390 with net income after all charges being \$1,242,600. Billing is of April 10: \$7,150,760.

National Advisory Committee for Aeronautics plans to let free technology research rockets into the path of long-range missiles from Wallingford Island, Va. The rockets will be equipped with sensors and air and electronic location and recovery devices. The rockets could come, already tested in the Navy, will disengage from the rockets at the end of their use and be parachuted into the sea for recovery by divers.

Ford Aircraft Engine Division, Chicago, delivered its 1,000th J57 engine to the Air Force Engine with reference to the F-100. Rebuilding three F-460 Wing Major production had to be completed before the 157 was delivered in April, 1954. A. G. Moore, general manager, said, "1,000 J57's would not be less than half the time required to produce the first 1,000."

New Bristol 102 helicopter will cruise at 80 kt and gross 17,200 lb with two pilots required. Later, Napier Gamma turbine-powered version will cruise at 120 kt and gross 11,000 lb on short range. The two engine tandem rotor helicopter will carry 25 passengers and crew at three. RAF has ordered the craft.



**THE LOCKHEED F-104A** is described by its maker as the world's fastest combat airplane. Such incredible supersonic speed calls for control systems that must be reliable beyond question, under every conceivable condition.

Rigid specifications for the F-104A's prototype, the XF-104, were entrusted to EEMCO, specialist in the design and manufacture of custom-built motors and actuators. Collaborating with the engineering division of Lockheed, EEMCO designed and developed six actuator systems as vital components of the supersonic XF-104.

EEMCO is now manufacturing actuator systems in quantity for the F-104A. EEMCO-designed motors and actuators are on the majority of the latest type military jet aircraft and missiles now being delivered to, or developed for, the U.S. Air Force. They are also being used in industrial applications where high quality and precise performance are vital.



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## GILFILLAN AUTOMATIC GCA



**AIRBORNE DISPLAY.** A remote and remote point continuously displays deviation and altitude data. A low level altitude mode continuously displays altitude and mode indicator automatic approach or to monitor the autopilot for manual approach or to monitor manual GCA. A low level altitude mode indicator displays altitude, a warning light automatically indicates pilot.



**GROUND DISPLAY.** Each of AGCA's is a heading indicator of low altitude only controls for low level altitude mode continuously displays altitude and mode indicator automatic approach or to monitor the autopilot for manual approach or to monitor manual GCA. A low level altitude mode indicator displays altitude, a warning light automatically indicates pilot.

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Gilfillan AGCA does not obsolete existing equipment, but functions as an excellent extension of present basic GCA and standard airborne instrumenting equipment, relieving the GCA operator of vocal transmission of data, and the pilot of the manual chase of flight path from AGCA, with one master, takes the place of his GCA operators and several GCA equipments.

AGCA obtains aircraft position from basic GCA, also transmits automatic flight correction data for radio-aided to standard airborne equipment, which receives out-of-range with correct up-down right/left control for smooth approach to the runway.

AGCA also provides the pilot with more information and complete altitude and smooth control data on his instrument panel at all times, enabling pilot to monitor automatic approach, or optionally, to override autopilot for manual approach without 3-dimensional data provided by AGCA, or to monitor standard GCA follow-up. While flying in RADC mode, the pilot can independently control aircraft as also presented as part of the continuous traffic flow, through the "block-in" system of automatic overtake warning and instant closed-loop indication of any deviation from safe landing track.

AGCA is the result of ten years of joint research and development by USAF Rome Air Development Center and Gilfillan.

# AIR TRANSPORT

## IATA Airlines Vote to Cut Atlantic Fares

International carriers reach compromise agreement at Cannes; CAB reaction to cuts may be decisive.

By Craig Lewis

**Washington**—The international airlines voted last week to cut Atlantic fares to a level which will force high-fare and low-fare patterns in the Atlantic flight corridors, sponsored by the International Air Transport Association.

The compromise line reductions have moved out at Cannes since a gradual approach to fix continued third-class service proposed by the Civil Aeronautics Board and Pan American World Airways.

The new fares are likely to be approved by all governments, and the CAB's reaction to the compromise decision will be a decisive factor. The IATA proposals are not what the CAB wanted, but they probably are close enough to convince the Board it should approve.

### Proposed Fare Changes

Here is the schedule for North Atlantic fare changes.

• **October 1, 1958.** A new 15-day excursion fare, goes into effect based upon a \$125 round trip fare between New York and London. Air carriers have not agreed to the fare. The fare is not in effect, but the carriers probably have agreed to it for enough in their fare to justify the program to start a relevant CAB appeal.

• **April 1, 1959.** The 10% increase in first class fare, that was also effect last April is extended, and the New York-London fare goes back to \$400 per seat, \$720 round trip. A new discount service, including sleeper seats will be added at \$975 and \$410.

• **April 1, 1959.** A schedule change will be implemented with New York-London fare cut from \$410 to \$340 with a complete validity.

Keith Gifford of British Overseas Airways Corp. and chairman of the conference said the new agreement "dramatically the determination of the scheduled airlines to give the public the largest possible quantity of high quality transport at the lowest possible price. This will require the airlines to make extensive changes, not only in their tariffs, but also in their equipment and operating plans."

Gifford said the airlines hope the new fare "will make the Atlantic a truly easy way by lowering transatlantic fares, a practical economic reality for Europeans as well as North Americans."

The IATA airlines also decided to offer a special excursion fare for west-bound travel at 40% less than the standard excursion fare. The fare will be valid between November 1 and March 31 for travel to the U.S. and Canada from all European countries except the United Kingdom, Spain and Italy where other plans exist.

On mid-Atlantic routes, the carriers decided to cut first-class fares beginning October 1. The fare is 97% less than a standard excursion fare. The carriers agreed to cut first-class fares \$30 per seat. A \$50 charge for sleeper seats also will be introduced.

### CAB Policy

The Cannes meeting was an attempt to convince airlines to make price cuts in the CAB when it limited approval of present fares and insisted that both first-class and lower fares should be lower (AWM May 28, p. 35).

The CAB does a close review of what it finds the North Atlantic fare structure is not what it is desired policy statement issued in May. The statement stated that the airlines' price was not the mark set by the Board, but the carriers probably have agreed to it for enough in their fare to justify the program to start a relevant CAB appeal.

When it reviewed the two entire plans proposed by Trans World Airlines and Pan American World Airways, the Board and TWA's executive vice president said the fare charged for travel between the points was high. Price between the West Coast and Europe will be the same in the fare on New York, and the below American carriers' decision to cut Atlantic will apply to these routes.

First class fares on North Pacific and Pacific routes will be cut to \$10 between North America and Tokyo and \$25 to other Asian points. No cut was made on transatlantic fares, but the carriers agreed to meet next spring to discuss a Pacific excursion fare.

The European fare pattern will be adjusted slightly upward, as will fares from Europe to the Middle East, the Far East and Africa and later between African points.

Carriers will likely have been adjusted to promote development of new types of cargo traffic as well, more, more by law rules for specific considerations.

The extra charges for sleeper seats allowed by the CAB is partially covered by the extra for offset service to start in April. IATA carriers will charge an extra \$50 instead of the \$75 suggested by the Board.

The decision on the new fare of the CAB's proposal, is scheduled for April 1, 1959, instead of April 1, 1957, as suggested in the Board. The \$400 fare is a slight increase from the \$370 proposed by the Board and approved by the CAB.

When they decided the third-class fare should become effective as the spring of 1958, the IATA airlines put off deciding definite limits and conditions for the new service until the IATA conference scheduled for the fall of 1957. At that meeting the airlines will decide what other classes of service they will offer, and what the relationship between them will be.

### Effect of World Prices

Gifford said it is essential to allow for some adjustment in the proposed third-class fare level at the 1957 meeting because it is impossible to forecast the effect of world prices on airline fares 18 months ahead. But he said the new fare would remain 20% less than the last highest fare.

Most of the action likely on Atlantic fares and the fare pattern in other areas around large the same. The carriers agreed with the CAB that the fare between Europe and Tokyo should be the same as the fare charged for travel between the points was high. Price between the West Coast and Europe will be the same in the fare on New York, and the below American carriers' decision to cut Atlantic will apply to these routes.

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## Some Airlines Show Enthusiasm, Others Are Dubious of Fare Cuts

By Glenn Garrison

New York—Concern of the Interagency Transatlantic Council is that the fare agreement reached at Geneva by the International Air Transport Association represents an unfriendly a compromise as they might expect. But plenty of private doubts remain.

Perhaps the key point in the fare agreement is its timing. Defunct at the end of the third class era in world 1950, it was a long way to take it to the point of finding agreement to handle the expected wave of loss of low fare travelers.

Most of the carriers have long-range equipment on order that will be in use by spring 1955. The breathing spell also allows time to study, experiment to help design configurations for the third-class flight.

The fare experts therefore perhaps infer a secret concern of many of the airlines, as expressed in the Geneva conference (NW, May 11, p. 39). After the fact that the 15-day maximum fare goes into effect (this ILE) is an advance equipment-wise. Many will be a little because of the off season.

Those carriers with nothing to say in public about the new fare are talking about British Overseas Airways Corp. "declines the introduction of the new low fares, their fares and no service tickets," with the airline "no profit" and expects "enormous" for the plane.

Air France is "perfectly happy with the new arrangement" and considers it a new step.

Norwegian Airlines System, referring specifically to the 15-day maximum fare, believes it will turn out satisfactory and offer more "shaded" services than first opportunity to travel abroad.

Many airlines, though, are keeping their ideas to themselves while they digest the economic implications.

All the American lines, Trans World Airlines is happy about the outcome of the conference, expecting "1955 agreement" with the voting. Pan American has "no comment" on the results.

Deep non-stop routes, however, on the part of some Interagency Council who went along with the compromise agreement. Among the points of an economy.

- Will the smaller carrier be able to service a possible equipment war when the main line class has been begun? If the small carrier can't afford enough aircraft to make up in volume what they will lose in passenger revenue, they may be faced with the alternatives of going out of business or seeking heavy

request from governments willing to maintain the prestige of a flag line over the Atlantic.

- Will passengers accept the high fares, which service planned for the third class? Some carriers feel the passengers may be so cramped and uncomfortable by the time they've flown the Atlantic that their reaction will be unresponsive.

- Will market conditions to the expected degree? This is a big factor, as some carriers who find that travel is almost at a standstill, might make it impossible to fill the greatly increased fleet even in the summer.

In other words, some carriers who could feel what they felt even in most likely economic situation of the same stage they lost before the IATA conference began.

One point of concern expressed by the conference was the adequacy of travel accommodations on both sides of the Atlantic to handle the influx of low-budget travelers. Now the fare goes into effect (this ILE) is an advance equipment-wise. Many will be a little because of the off season.

Still very much in the runway mail is concerned against the Civil Aeronautics Board as its present position statements in forcing the third-class plan.

## Airlines Call Lease Plan 'Huge Success'

Washington—Shel, Annen and Fligging, Inc., a New York-based law firm, has advised airlines that the 1954 DC-6A lease contract with the Navy is a huge success. The two firms would like to see the program expanded, and both have high hopes of getting more equipment through the Air Force under similar contract terms.

The demand by the two firms has to quit the Air Force to follow the Navy's program stems from the high load factors and the excellent utilization of the aircraft leased from the Navy in August 1953.

During the last nine months there were four times as many aircraft as the Navy's fleet. Fligging has reported a month's load factor rising from a low of 72.5% in September 1953 to a high of 79.3% in April 1955.

- Under the Navy's lease of 1211 planes in March 1954 to a high of 3.02 times in August 1954. Average utilization reached 90.5%.
- Monthly load factor on the Shel month shows a low of 67% in April 1954 and a high of 62% in August 1955.

• Shel's utilization needed a high of 10.49 times in August 1955 and a low of 7.05 times in February 1956 for an average of 9.01 times.

The Navy program was created last year by the Air Coordinating Committee. Under the contract each company, leased from the Navy, one DC-6A, military version of the DC-6, as an aircraft lease with a military conversion. Rental of each airplane is \$212,000 yearly.

Operation is restricted to commercial service and may not be diverted to military contract or charter work. Each carrier also is required to place an order for a civilian DC-6A in an amount of equivalent capacity, each time the contract is renewed. The Navy may cancel its plan at any time.

The Air Force contract presumably will be done up along similar lines in its proposed program. The Air Force is considering leasing of two DC-6As and three DC-4s.

At least one huge domestic carrier has been highly critical of the Navy program. It contended that the cargo load was not sufficient, developed in the military version of the plane. The plan, however, "Government extension into the domain of private enterprise." The airline also charged that growth of the lease plan might discourage investment of private capital.

The Navy is worried with the results of its lease program. Navy has to cut out its potential equipment with fewer aircraft and that loss of the more planes will limit development of the air transportation, creating a more efficient traffic flow in terms of equipment.

Navy backs this belief with traffic figures showing a 25% increase in cargo volume by its leased aircraft from 1948 to 1955, compared to a 42% increase in "normal" carriers for the same period. One Shel official admitted that his company might have been serious financial trouble had it not been for the relief provided by the Navy DC-6A.

Navy also contended that the program would stimulate the purchase of additional equipment, be private or military. This has been denied by Fligging. The order for 10 Super Constellation 1049B for delivery in 1957 Shel purchased 3 DC-6As last year and this year placed an order for an additional five.

In another program, the Navy, this far has leased to an carrier 25 DC-3s. 18 of which have gone to local service airlines. Two Navy DC-4s have been leased, one to Trans World Airlines and one to Motor Airline. Under the plan, there is no restriction as to the areas in which the planes may be operated and the leases don't have the purchase order provision contained in the Fligging-Ten and Shel contracts.

## East Coast Case Will Define CAB Policy

Washington—The New York-Florida case, now moving into its final phase, will give the Civil Aeronautics Board and its two new members their first chance to show whether they intend to follow the new philosophy of airline competition followed by the CAB last fall.

Both have been tied in the body control case, and the Board will have an opportunity to expand its role in the work.

The CAB's decision in the New York-Florida case is important not only because it will define a new airline pattern of control system, but also because it will show whether or not the Board intends to continue to follow the competitive philosophy it established in a series of earlier cases last year.

In 1953, the CAB ordered a major review of the airline market pattern in three cases—New York-Chicago, Denver-San Francisco and San Francisco-Norfolk—where it found excessive competition among trunk airlines, subsidiaries and regional airlines, and ordered a new pattern of airline service to be a considerable degree.

### Change in Pattern

When it changed the pattern of competition, the Board and its present aim to strengthen the position of the smaller trunk airlines and cut down the size gap between these lines and the Big Four—American Airlines, Eastern Air Lines, Trans World Airlines and United Air Lines. The CAB took the view that stronger regional airlines would be able to compete more effectively with the larger carriers.

In some disputed cases, it was a two-carrier system which carried the competitive philosophy through the three cases that represented the first major review of trunk routes in several years.

Now, the members of the old regime—Rogers and John Lee—have left the Board and James H. Duffice and G. Joseph Mauch have been appointed to replace them. The New York-Florida case will give the new Board its first major opportunity to demonstrate what policy it takes on the important question of competition among airlines.

This battle over the East Coast route involved in the New York-Florida case has been fought against the major competitors. Eastern and National Airlines have struggled to keep the long haul rates between the northeast and Florida for themselves. Now other airlines have fought just as hard to get into the passenger-carrying markets in volume in the case.

A part of the battle has revolved out

of the battle of the CAB and into the economics involved. There has been considerable effort among the airlines to bring to bear the influence of rates and rates that be along the eastern seaboard.

### Commonly Promotes

The New England area has put most of its support behind Northeast Airlines' efforts to expand its routes in the north.

Northeast has had support from the states it serves and from the congressional delegations from the New England area.

Pan American World Airways' attempts to launch a domestic route have been supported by the states of New York and Baltimore. New York thinks Pan American can start new service faster than any other airline and Baltimore says Pan American because the carrier has "expressed its intention and desire to use Friendship Airport to serve the Baltimore-Washington area."

In a letter to Maryland Sen. Mansfield Butler, a leader in the fight to improve service to Baltimore, National's Vice President Alexander G. Hays and Pan American's president to see Baltimore's influence is in competition with them.

Both, and Pan American "has been handling Baltimore for years" and its interest in the city is a "substantial financial play."

So far, Delta Air Lines is the best

position in the race. CAB member Thomas L. Waters has advised the Board that Delta should be the third carrier on the New York-Florida route.

In support of the summer's decision, Delta's best and the airline would offer the greatest amount of service along the East Coast with a minimum change in its routes. Delta says that it already is established in most of the cities on the New York-Florida route, and that a policy of rounding out the pattern of an airline already in the area, rather than bringing in a new airline is the soundest approach to the situation.

Delta also argues that it would give a low amount Delta to National and Eastern than other carriers. The effect of a third carrier on National was a major consideration in the summer's report.

Opposing the certification of Pan American in the north, Delta said it would break down the National (Pan American) Pan Am's advantage to South America and transfer National's interest in Delta and Pan American, two of the airline's largest carriers. Delta threatens that first probably would put National back on probation.

### Pan American's Stand

Pan American told the CAB the highly seasonal New York-Florida route fits the PAA pattern best since its traffic peaks are in the summer season. The airline said it could offer a second type of service, between the north-



Delta Golden Arrow

Coast Golden Arrow routes may also put another carrier Delta Air Lines making in the north. Delta has ordered five new DC-6As for use on the Golden Arrow routes.

and Miami sent water, many of them with DC-7C equipment freed from Atlantic service by slack winter traffic.

Pin American said it would have the advantage of offering single carrier service to international ports, a service that is lacking at most carrier points. The airline is particularly interested in having a direct link between New York and its extensive Latin American system and sees an interlinkage as not the proper solution.

Replying to arguments that cancellation of Pin American would damage National, Pin American said the argument is based on an expected air route path and down the private interest of an airline over the public interest. The airline said it is to be noted that National has grown to where it can stand the competition and estimated that Delta would divert more service from National than would PanAm.

#### Support for Northeast

Northeast Airlines has had the support of the CAB's Board of Governors in the case, but the consumer group is strong against the choice of New York for the route. Executive Women questioned the airline's ability to run a route effectively in the Northeast. National said it suggested that the CAB look into the relationship between Northeast and the Atlas Corp. which controls it.

Northeast and the CAB has approved all investments and schedule changes with Atlas, and there is no harm for anyone. Northeast also argues that it is a better choice than Delta for the route because its national system serves the needs of the Northeast.

The New England airline contended that it is the carrier in the case least capable in need of strengthening, and the only applicant without dependent carrier certification in New York. Florida Case for such strengthening. Northeast also argues that it would offer more non-stop carrier service than Delta.

Northeast told the Board that it offers the prospect of important subside, elimination of it gets the route while it will probably require permanent subsidy if it fails to get it.

Capital Airlines offered the route as being important in the Northeast and said that it would be able to offer more new employee service to Florida ports than any other carrier in the case.

Capital said the CAB is more concerned in the long-term Northeast Florida market in order to improve its financial position in the industry. The airline said the new routes it announced with New York, Chicago and South-South Northeast routes have failed to cure all of its difficulties.

Concluding questions concerning the ability of Capital's Vincent to compete with DC-7s, the airline said no one has seriously considered that it could not operate profitably with the long-range transport. The carrier said the Vincent would be a superior aircraft to the market Capital has asked for and that it plans to buy never more modern equipment when it is ready available.

Capital reportedly has reached a local-area deal of \$750 with its Vincent and plans to eventually reduce the franchise point to \$1,500. Direct costs in the Vincent are reported to be about five cents a mile below the original estimate of \$3 cents.

Both Eastern and National continue to dispute the point of view of the airline and the other airlines who are due to make for another carrier on the East Coast route. The two airlines feel that the route is currently serving the best of service and will continue to be well served as their offers for new equipment are filed.

#### Opposition by National

National pointed out that Delta criticized it and said it is willing from National if it gets the route. National said Delta would force it back as a subsidy, despite losses it relies in New York-Florida traffic for the major part of its revenues and profits. The airline said certification of Pin American would be even more damaging. National said such certification would result in a battle of the public-Pin American and Eastern—with the smaller carrier-National and Brazil-trumped underfoot.

National also contended that the only sound solution to Northeast's problem is combination with another carrier. National argued an offer to let Northeast and take over its route system.

National said its biggest problem is to find ways of overcoming the effect of the economic propaganda and public opinion which has been exaggerated in the reaction of the numerous applicants who have lined men and organizations to their support by means of newspaper space. It added:

"We only ask the Board to consider the facts of record and give serious consideration to the effect of a implication of National's note in the civil case, which does not turn out to be just paper in this instance."

Tature points out that Ruffalo Airlines has been eliminated to carry cargo on the East Coast route and now even supplemental air carrier on offer a limited scheduled service in competition with Eastern. National said the airline would adapt their equipment and also proposals to South America's problems.

been so detailed of traffic support through the sequence of competitive growth throughout an entire length and breadth the only "radius" which has on would have left if the carrier's recommendations were adopted would be the bare bones of a one-carrier air transportation system."

#### Executive's Report

Among the various shorter routes along the East Coast that are involved in the case the Washington New York Boston segment is the most popular. The carrier recommended that National be allowed to operate a thru service from New York to Boston. It also favored Capital for a Norfolk-Washington-Baltimore-Philadelphia-Newark. New York route to put the carrier in the market and the New York-Florida route recommended for Delta would allow that carrier full participation in the Washington New York market.

The consumer also recommended that Eastern's New England restriction be lifted so that the airline can operate local service between Boston and New York. He also advised the CAB to close the gaps in the routes such as the route between New York and TWA. This would allow the two carriers to operate between the region, explain miles with long local restrictions.

National, Capital, Delta, TWA, United and Eastern are all in favor of the new service proposed for them in the Washington-New York-Boston segment. TWA and United want to let it operate local service in the area.

American and Eastern object to more competition on the Boston New York-Washington route. American said the service is already plentiful and that traffic conditions in the New York area will not permit a new carrier to add a significant number of flights.

#### Berta: South America Needs Easier Credit

American aircraft manufacturers will face increasing competition in South America from European producers unless their case there could be made, the president of Varga Airlines of Brazil stated at a recent New York meeting of the Foreign Committee of the Associated Industries Association.

Robert M. Berta told the AIA members South American airline operators have been able to buy only by the most expensive terms and by the most expensive terms and by the most expensive terms.

Tature points out that Ruffalo Airlines has been eliminated to carry cargo on the East Coast route and now even supplemental air carrier on offer a limited scheduled service in competition with Eastern. National said the airline would adapt their equipment and also proposals to South America's problems.



PORTABLE container lifts, one for each door of DC-6A, plus a big pig in two-hour turn-around loading and unloading operation.

## Quick Turn-Around Pays Off Cargo Line

Through efficiency of operation and high personnel efficiency, Flying Tiger Lines has cut turn-around times for its trans-Pacific cargo flights to the bone. And on at least one instance, that operation is paying off in an additional flight with no addition of equipment.

For example, a former Northland flight out of Newark at 10:30 pm arrived at Berkeley, Calif., at 7:30 pm. It didn't get out until 11:30 that night. Now the same flight arrives at 6:30 am and leaves again the same morning at 8:30. It gets back to Newark at 7:30 pm and departs again at 20:30.

Some carriers are cut the time between a seaborne route at Detroit and the landing of 7,000 lbs. of payload to avoid an additional gap stop, but the net loss to that company was the cutting down of losses time.

Frank Linnell, FTL vice president operations, estimates that Flying Tiger gained profitability in reducing loading and unloading flights at about two hours during the last few weeks of schedules are operative. Longest ground time at any point is three hours, three carriers.

Below the airline began flying on the new schedules last month, three hours was considered the maximum time for taking 10,000 pounds of a DC-6A, per tug machine 10,000 pounds should be.

Objection of cost of the last few DC-6As is coming, about 15 years old, according to Linnell. Ground handling of cargo is spoiled by a use of two carriers, one for each door of an aircraft. Emphasis is placed on getting the unloaded cargo delivered by truck with a minimum of delay, and Flying Tiger is considering adding other in its own leased trucks to expedite this.

To keep pace in the shipping line from airport to consignor, Flying Tiger now IBM's information from delivery reports.

To avoid maintenance delays, FTL pilots make two hours in a three distribution to arrive at an mechanical problems. Mechanics meet the plane prepared to check repairs and make adjustments. To eliminate personnel problems, Linnell told how crew members used to make opening cargo doors while the aircraft was still rolling. But Douglas Aircraft advised against the practice and it had to be discontinued.

Under its recently granted authority, Flying Tiger is cutting increases at a rate of about \$15,000 a month for fuel and \$55,000 a month for express costs according to President Robert Prescott.

In making the most efficient use of

its DC-6As, Flying Tiger has reduced its use of the less expensive C-46. The ratio has changed from 60-40 in favor of the C-46 to 10-90, and the goal is an 80-20 ratio in favor of the Douglas equipment. Tiger operates the C-46 for about 18,155 miles a year and equipped with 6.7 costs for the DC-6A.

Prescott said he had consulted with Boeing about possible cargo use of the 707, and that in operating cost figure of 34.4 cents a ton-mile had been discussed, with a 707S-800 payload over an 800-mile run.

The Lockheed Electra also would make a good cargo airplane, Prescott said, if the company were interested in adopting it for that use.

## United Starts DC-6A Cargo Service

Los Angeles—Additional fast transcontinental cargo service was allowed the nation's shippers and distribution recently when United Air Lines put two DC-6As equipped with cargo doors.

United's all-cargo flights follow a new service introduced by American Airlines which runs in operation since DC-6A and so DC-6A all-cargo flights.

United has scheduled the two new combinations for departures five nights a week from both the West and East Coast. Schedules will be increased near the end of July when the airline takes delivery of three more all-cargo DC-6As. With a complement of five cargo planes added to a fleet of eight all-cargo DC-4s and 175 combination passenger cargo planes, United projects a 70% boost in its cargo business.

Features of the cargo line include: • Cargo cabin is long with 4,411 sq ft of space. Lower aft and forward compartments provide an additional 500 sq ft. Two narrow cabin

doors facilitate on-and-off loading.

• Doors 61 ft high and 104 ft wide. • Double-lined cabin and lower aft and forward cargo compartments. Cabin deck is constructed of corrugated sheet metal with a covering of aluminum alloy. It supports loads of 100 lb per sq ft.

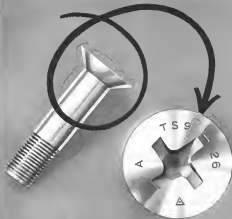
• Air conditioning system which maintains flight temperatures of from 41 deg. to 73 deg. Separate controls are provided for ventilation in the cargo cabin and cockpit temperatures.

United featured "Cargoport 1956" in line when introducing the new service. After inspecting the interior of the cargoport, visitors witnessed a freight handling demonstration, watching special tools, designed for fast on-and-off loading, move better than

The airline believes its method of combined cargo control and its service as freight progress helps the passenger operation concept into air freight.



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uct, which makes possible unlimited production enhanced by the fine physical properties of cold forming.

For complete information on the ways TORQ-SET can be applied to aircraft production, write, wire or call American Screw Company, Wilmette, Conn.



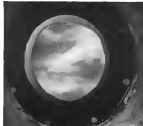
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SATELLITE conditions in job of hypersonic wind tunnel.



RE-ENTRY under satellite conditions is duplicated in tunnel.

## Gas Dynamics, Part II:

# Hypersonic Quest Yields New Techniques

By David A. Anderson

New families of test facilities to simulate the unusually rigorous and different requirements of hypersonic and supersonic flight are a major development area in the growing science of gas dynamics.

The transitional needs of the vapor cone, transonic, supersonic, free-flight ranges, aerodynamic test vehicles—have been adapted and extrapolated to higher speed ranges.

But these inherent limitations have forced an inventive approach to more technical techniques that use the limitations of an electric arc, the powerful except of a compressed high gas or the heating strength of an electric arc to simulate the velocities of microcosmic ballistic missile flight.

Simulation of the greater flight paths of an intercontinental ballistic missile or the earth satellite is a matter of getting and maintaining the proper flow conditions and patterns around the

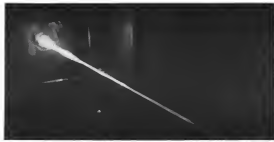
vehicle. There is no difference whether the model moves through still air, or the air moves past the stationary vehicle.

Both approaches have become standard and techniques in aircraft and missile development. The wind tunnel with its varied modifications for free jet, blowdown, molecular beam or shock-tube apparatus remains the fundamental type of air mover facility. Free-flight vehicles, ballistic models, fixed down, water-tunnel ranges and tank test slots are current examples of the more recent facilities.

The choice of test apparatus is dictated by many factors. One of the primary considerations is the type of parameters desired. Generally a wind tunnel provides static or steady-state data; the model is tested under equilibrium conditions and the data obtained includes lift, drag, pitching moment and moment values. The moving mass test apparatus generally gives dynamic data such as the transients during starting and stopping and the qualitative and quantitative measures for aerodynamic stability.

Both kinds of facilities have drawbacks. Wind tunnels can be used only to provide much transient and dynamic data, moving mass tests produce large quantities of steady state parameters. But these general values are in outline.

There are some of the problems and



MACA'S AMES LAB light gas gun fires model projectiles at speeds to 10,000 mph. for simulation of satellite and missile reentry.

program area in the simulation of unique flight problems.

## Wind Tunnels

Certainly the wind tunnel is the most valuable test tool of the aerospace engineer. During its years of development it has continuously been improved, its speed and altitude capabilities expanded, its instrumentation and data recording automated, keeping pace with advances in the structural art.

Irrespective advances in instrumentation and data-gathering techniques have made it possible for wind tunnels to produce more and more data points in less and less time. Automatic and real recording and data plotting computers have been able to produce continuous plots of aerodynamic data while the model is completing its test run.

But the quality of the test results depends on the quality of the air inside the tunnel and that's the catch. A hypersonic tunnel reaches proper test velocities by expanding compressed air through a supersonic nozzle upstream of the test section. Expansion cools the gas and the greater the pressure drop the greater the cooling.

For Mach numbers approaching five, the temperature drop of the expanding air is enough to condense out moisture in the air, giving a fog in the test section and changing the test results. To beat this, wind tunnel designers added deers to remove the moisture from the ambient air. This increased the Mach number range available.

At higher values the temperature drop low enough to condense the air itself in the test section. The only way to avoid this is to heat the air

upstream of the test section so that the temperature drop will not go low enough to get condensation.

For hypersonic speeds, the heating and firing requirements become enormous comparable in magnitude to the power required to drive the tunnel. The heated air should be at temperatures of several thousand degrees Fahrenheit to eliminate hypersonic complexities, and the sort of temperature could melt down a tunnel structure.

## Helium Tunnel

One way to avoid liquefaction is to use a gas that doesn't liquefy at the test section temperatures. Helium is one, and it has been used successfully

in a hypersonic, intermittent tunnel at Princeton University.

Test section velocities up to Mach 20 have been reached in the tunnel. Actually tests in a helium tunnel do not simulate the flight problems exactly.

The greatest value of these tests is in their contribution to the understanding of the fluid dynamics problems.

The Princeton tunnel is a blowdown type. High-pressure helium upstream expands through a supersonic nozzle and into a reduced pressure area provided by a downstream orifice or throat. The helium comes in the Navy's standard tank seven-fold



TEST TANK is part of Ames gun, records photo stations for data recording.



CORNELL HYPersonic TUNNEL at 5,000 mph. is photographed by its own light.



which disperse the storage system. Tunnel test times are as long as ten minutes at stagnation pressures as high as 2,000 psi.

#### Molecular Beam Tunnel

At the other end of the speed range is the University of California's molecular beam tunnel for the study of superconductivity. It resembles no other kind of wind tunnel. It looks like a miscellaneous collection of leftovers from a physics laboratory.

The major value of this tunnel is its operation at extremely low pressures—down to one ten-millionth of a sea level atmosphere. The model is tested in an evacuated chamber in line with the free throat of the test section.

Diameter of the throat is one ten-thousandth of an inch. It is the outlet for a beam of molecules generated in a furnace whose temperature determines the speed of the molecules beam. For a furnace temperature of 1,500° the speed is 1,500 mph. The beam is focused and controlled by a series of slits to produce the desired kind of test.

A by-product of the tunnel has been the development of an extremely sensitive

two diaphragm pressure gage which can detect changes on the order of one ten-billionth of a sea level atmosphere.

Speeds approaching Mach 40 and gas temperatures around 10,000° that of the sun's surface can be reached in the shock tube and its variants, the shock tunnel.

#### Shock Tube

The shock wave itself is used as the driving force in a shock tube. It reflects down the tube, driving the trapped gas ahead of it, compressing and heating it to test values. The whole process takes only a millionth of a second so that the temperatures involved never last long enough to do damage to the facility.

The geometry of the shock tube is simple. It is a long cylinder divided by a so-called diaphragm designed to fail at a predetermined pressure. One side of the tube is pumped to a high pressure and held. That pressure is suddenly released either by an explosion inside or by a solenoid-driven piston in the pressure.

The diaphragm ruptures and the high pressure air races into the low pressure section, producing a strong

shock wave which races down the tube ahead of the pressure front. Compression of the air ahead of the shock wave produces a pocket of high-temperature gas which is the test fluid.

The only possible ways to get test results during a run of such short duration are photographic and electronic. Photographic qualitative data, such as flame temperatures, can give quantitative results. This is the major reason the shock tube has become an air data tunnel test tool only recently, although it was invented before the turn of the century.

A 100-ft. long shock tube is in operation at Aero Manufacturing Corp.'s Research Laboratory, simulating re-entry conditions at speeds of Mach 15 and gas temperatures approaching 15,000°. A shock tube under development at the University of Maryland is expected to reach Mach numbers of 40.

#### Shock Tunnel

In expanding the hot gas pocket through a supersonic nozzle it is possible to extend the useful range of the shock tube to a more accurate simulation of hypersonic flight. This has been done in the shock tunnels at Cornell



Flight firing tests in early Rocketdyne engines helped speed the development of today's models whose power cannot be duplicated.

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#### Chrysler Simulates Redstone Flight

CHRYSLER CORPORATION is simulating flight tests on Redstone missile on shifter at top in a Hercules at its Jet Engine Plant near Detroit. Data broadcast from nearby by live television transmission is received by control room crew (right) on cassette tape or video disks. Circular air gauges developed the shifter for testing while useful as an addition to test of components. It is made of various wire concrete welding clamped over aluminum framework.



Aerospace Laboratory, which speeds its tests of Mach 32 live back ground.

The difference between the conditions of the shock tube and those of the shock tunnel stems because of the high temperatures generated during the process. The speed of sound increases with gas temperature increases. At the very high temperatures generated in the shock tube, the velocity of sound is also very high. This operating Mach numbers can be only moderately supersonic, at levels of Mach 2 or 3, for example.

Use of a supersonic nozzle means that the temperature can be dropped and the Mach number increased, bringing temperatures for Mach number right down to the desired test conditions.

It is just the shock tunnel because an intermittent blowdown type of wind tunnel with the driving medium being the high-pressure, high-temperature gas product of the shock tube.

#### Free-Flight Vehicles

The real value of the shock tunnel lies in its versatility. It is capable of producing simulated flight data on missile models or of studying the basic physical and chemical properties of the gases in the earth's atmosphere. It offers probably the best chance to determine the transient phenomena behind a shock—the energy transfer, transport properties and reaction times—and the relation between thermodynamic and electrostatic behavior.

Well, expendable models of full scale aircraft and missiles have given data on the free-flight test vehicles, revealing the dynamic characteristics of their big relatives under flight conditions. The use of such vehicles permits verification of sophisticated instrumentation to record and transmit data during flight. The constant and steady-state phenomena can be measured during a single flight to a high degree of accuracy.

In the field of hypersonic research the aerodynamic test vehicle is apt to become a specialized instrument for gathering specific kinds of data rather than for simulating a complete missile flight. Current concepts of hypersonic test vehicles are being used to establish test transfer data, particularly overall heat transfer for comparing the free-flight values with those obtained in wind tunnels and shock tubes.

One research unit, the RITV (jet prototype Test Vehicle) developed by Wright Air Development Center of the Air Research and Development Command in cooperation with Aerophysics Development Corp., has been used for aerodynamic test flights almost exclusively.

The Lockheed X-17 hypersonic vehicle is another example of a current program. The X-17 is a two-stage solid propellant rocket.

#### Light Gas Guns

The art of ballistics, grown to a science during the past century, has contributed to the extent of flight research with the development of its usual family of guns. Using light gases

instead of powder charges, there is a reason—just a pair of a general class called nose aerodynamics—on blast that projectiles at speeds starting at the 10,000 mph mark and increasing to speeds approaching 20,000 mph.

The principle of these guns was developed at the New Mexico School of Mines from a proposal made by Dr. W. D. Crozier. The NMMSI group under Dr. J. J. Wilkins developed a gun using hydrogen as the gas.

The reason for using a light gas stems from the first law on total available energy in the propelling charge. When the gas is released, some of it goes into accelerating the projectile, the rest goes into accelerating the gas along with the projectile. Obviously the lighter the gas, the more energy available for accelerating the projectile.

Aerodynamics Laboratory of the National Advisory Committee for Aeronautics is operating a helium gas as the model for a larger future gun. The velocity of the light gas is a few percent less than the velocity of the helium gas. The data gun will be able to handle projectiles up to 3-in. at muzzle velocities of 10,000 mph. These test values will handle the aerodynamic problem for any reasonable Mach.

There are several ways to use the light gas gun. Normally fired through an atmosphere pipe, it can also be discharged into a tank with internal pressure and air composition and use variable a trajectory of flight path.

Another possibility is to fire the gas upstream through a wind tunnel working section, a technique proven at Ames during the past several years with gas instead of powder-driven guns. Expected speeds with the model behind gas fired into a supersonic wind tunnel reach Mach 10, the full-scale gun should provide velocities up to Mach 30.

#### Electrical Means

A high-current electric arc is a source of several times the heat energy found in chemical combustion. However, the kind of a dynamic mechanism would seem to be a developmental step forward for the mass accelerator. Using an arc discharged in an atmosphere at helium, the limiting velocity is about three times that of the gas, which indicates that practical values of perhaps 10,000 mph could be achieved in actual testing.

It has also been suggested that the electrical arc be discharged accurately behind the projectile in a vacuum through the gas instead of only in the barrel. This would reduce the speed down of the pressure which then goes behind the projectile and greatly increase the acceleration of the mass.

Two other approaches to obtaining high speeds involve the use of electro-

magnetic energy. The first is a linear accelerator which would set up a field of rapidly moving electromagnetic waves and turn the test projectile along at extreme speeds by induction. This was tried experimentally in 1917 at the University of Utah.

The second technique would use the destructive heating force generated in a rod when a high current is suddenly applied. It also uses the test vehicle would be due in part of the rod and would be free to move in the radial direction of the heating force.

All of these techniques have been suggested and many of them tried in some of producing light conditions in a laboratory. The testing is not a complete ending the history of development programs has shown that in some cases, magnetic test techniques are developed in the programs go. Ideas are discussed and adopted from other fields of technology to turn out data.

Development programs live on their test results. No matter how complete the tests, how complete the analysis, there are gaps between the data and the answers in flight. The final value of the SCV and the missile programs will depend on large amounts on the precision with which results and experiment data can be compared and deposited the design conditions of flight in those test results.

Asks Senate Program To Train Scientists

Washington—Sen. Mike Mansfield (D-Mont.) has proposed a five-point program to help alleviate what he terms the country's "acute, almost catastrophic shortage" of scientists and engineers.

Pointing out that in 1974 the Soviet Union graduated 51,000 engineers and the U.S. 21,000, Mansfield asked the Senate to approve a program that would:

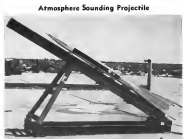
- Expand the National Science Foundation's scholarship program for college and graduate students in the natural sciences and engineering. Under the plan, the government would underwrite the college education of a selected number of high school students who display "special" capabilities.

#### Asks Senate Program To Train Scientists

• Establish a federal government program to help the states pay the salaries of high school science and mathematics teachers.

• Revise the Selective Service program to make allowances for students and graduate students studying the sciences and engineering.

• Increase the job and retirement security offered scientists, engineers and technical personnel.



NAVY solid-propellant rocket, ASF, for gathering weather, oceanic data, on coast of Mach 3 shortly after launch. Herring Canyon, Ariz., Mountain, Calif., developed it.



ASR, 12 ft. long, 64 in. in diameter, carries a small high frequency transmitter on board for relay data to ground. Rocket is fired from portable racks.

#### Mounts Aid Missile Reliability

Torrance, August, N. J.—Missile development is speeded as much as two years by the proper application of custom-designed shock and vibration mounts that permit vital guidance and control equipment to survive during the hard test vehicle course of the weapon, according to C. S. Robinson, president of Robinson Avionics, Inc.

Robinson's results began in 1949 when it was a 41,000-lb. position and laboratory facility in Torrance, twice the size of the firm's present plant. The company makes a shock

and vibration mounting system designed around a limited critical mass cushion.

One school of thought in mounting missile equipment is to keep up the system for rigid attachment to the chassis, Robinson said. The method, he said, requires redesign and redesign of the missile equipment, resulting in excess weight with no guarantee of success, and attendant waste of time, money and engineering talent.

The better approach is to roll in vibration and shock current specifications early, he said. One Robinson representative

Higher Aircraft's Polaris cruise missile will be given automatic checkout under simulated flight conditions using the elaborate automatic tester. Driver probes and a pass/fail record of its findings on punched cards, giving quantitative indication of how far missile deviates from desired characteristics for use as quality control studies. Machine automatically cuts into own memory against built-in standards, prints out results on punch cards. Tester was built by Electronic Engineering Co. of California.

#### Simulator to Test Polaris



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control only means equipment reliability problems that threatened the success of Chance Vought's Republic. The Textron firm wanted it out, but it took 50-60 mounting systems to handle the job. On projects where they have been called to make down systems an installation. A concept favored by Robeson engineers is to put all possible guidance equipment in one shock-mounted package, rather than handle the various shock-borne individually.

In addition to working with the air frame people, Robeson also is called in on problems involving shipment of equipment. One example was the static platform built by Ford Instrument for Robeson. The delicate equipment had to be hand-packed and hand-carried to the airport for delivery; these problems costing \$500 per shipment. Robeson developed a mounting system for a reusable container costing about \$800 that could be handled conventionally, saving a lot of money and effort.

The company has 2,500 defense models of M-16 Flex shock mounts of about 25 different basic designs in its files. Many of the components are standard, permitting a wide variation of configurations using basic hardware.

Applications are being extended into the industrial field where the company is pushing the use of the mounts on machine tools. All heavy equipment in the aircraft industry stands on shock mounts, reducing vibration and shortening the need for finely detuning the equipment to the floor. The firm type mounting makes it easy to move machines on and off the plant floor.

The company's new laboratory has three times the former area. Among the new equipment is an M-16 electro-magnetic vibration table that can operate up to 2,000 cps. Formerly aerodynamic shakers operating at 50 cps had been adequate, but the increasing performance of new weapons has caused considerable upward revision of requirements.

The company expects to do about \$4 million business this year, its highest total, approximately 51% of it military. Total volume of aviation business has declined in the slow market in spite of approximately \$15-\$20 million a year, he says.

## Dominican Republic Lets Contract to Martin Co.

Baltimore, Md.—Generalissimo Trujillo of the Dominican Republic has awarded his government has contracted with the Glenn L. Martin Co. of Baltimore for a nuclear-powered electrical generating system for his nation.

Under President Raulston's Atomic-Fuel-Power plan, contract is being given as a bilateral agreement between United States and Dominican Republic.



## The Sharpest "Nose" In the World

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## How to parry a jet's thrust

**J**ET AIRCRAFT have to land "fast" and fast—all the while hoping not to run out of runway or burn up their brakes on the process.

The simple solution would seem to be to slow the landing approach by simply cutting the throttle.

But once slowed below a certain level, some jet engines take as much as twelve seconds to regain full power.

This power lag could spell trouble if the pilot had to "pull up and go around again."

Some time ago the Air Force asked Goodyear Aircraft Corporation to see if it could engineer a means of slowing

a jet engine "into reverse"—so that its thrust could be utilized as a brake to slow these finicking planes over they touch the ground.

In effect, a device was needed which would serve the same function as the reversible pitch propeller used on piston driven airplanes.

But a jet is a different breed of cat from its piston driven forebears.

To tame its forward thrust called for deflecting—changing the direction of—the white-hot rush of gases which emerge from the engine's nozzle at some velocity.

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and money by pointing the way to elimination of non-reversal drive brakes and supplementary deceleration stages.

The result: better control, maneuverability, positive ground-control action which will eliminate the strain now being imposed on jet aircraft brakes at high speeds, shorter landing runs. In short, a new margin of landing safety for this nation's jet armor.

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## Contractors Agree On ICBM Transducers

Freedom-Requirements for precise instrumentation in the intercontinental ballistic missile program were coordinated here at a symposium sponsored by G. M. Gossens & Co., Inc.

Attending were representatives of 14 contractors in the ICBM program, all the Air Research and Development Command representatives and Gossens.

Previously, Gossens had been approached by a number of the contractors with a series of requirements for precise transducers for the ICBM program. These transducers, though basically similar, involved a number of substantial variations. Gossens officials felt that they could not supply these with in the short time allowed.

The constructive superconferencing was arranged at the symposium to determine whether transducer requirements could be consolidated to permit on-time delivery of the precise instrumentation and to eliminate possible production differences in later phases of the program.

Detailed demands for the precise instrumentation were examined and suitable compromises were decided upon to facilitate delivery.



Double Check

First phase of Boeing-designed UH-121 jet turbine (around Mount in NATO code) in Czech markings. The photo is a development of the standard Boeing-designed light bomber which has been operational with the Russian and Soviet Union for about five years. Foreplane on two B-24D tailfins, rated at about 5,000 lb static thrust each. Speed is in the 100 mph. class. Overall length is about 42 ft., and wingspan is 60 ft.

Also presented were specifications for new pressure transducers which will be available for production in the near future.

It was felt that even these advanced units would have to be upgraded in the future.

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# Electra Structure Reveals Refinements

By Irving Stone

**Boeing-Lockheed Aircraft Corp's** turbo-propelled Electra includes structural refinements based on the company's long experience in the transport field.

Integral stiffening has been effectively applied in the new design. Large single-piece fittings are used and chassis welding has been minimized.

A general analysis of the Electra structure reveals these highlights:

- **Fuselage skin** is 2024 aluminum alloy (temporarily 7075 aluminum alloy) at approximately .75 in. section thickness at about 6 in. spacing.
- **Chassis boxes** are supported by extruded aluminum beams of 7075 aluminum alloy. These beams are chemically anodized to increase corrosion resistance.
- **Heavy extruded 7075** ring frames are used in areas of controls, such as cabin doors and other stress regions.
- **Mainwing 7075** forged fittings are used to attach the leading edge to the front and rear wing beams.

A stress-bearing pressure bulkhead is installed at the rear of the fuselage, but a flat pressure bulkhead is used at the forward end to allow flow for weather radars at the nose. Four doors in the forward bulkhead give access to instruments and controls.

## Engine Cockpit

Cockpit is extremely spacious and unobstructed, large windshield panels. These panels comprise a pair of bearing rails, which have been solved by using heavy extruded 7075 posts and heavy 7075 sheet metal side to meet full-size requirements. Each post is made up of three elements and the side also are of multiple piece construction.

Two large 7075 cross type fittings, about 100 in. long, double in service by supporting the cockpit floor in well in the rear gun.

Supporting the main cabin floor the flight system is a bulkhead located at a cargo production joint. Underneath the main cabin floor and immediately aft of the bulkhead is the forward engine and baggage compartment. Access to this area is through a door approx. 42 in. by 32 in. This door, like all other in the Electra, is an equalizing spring type in a safety position to prevent door blowout from pressurization.

Structural reinforcement around this



**EXPLODED VIEW** shows that pressure bulkhead forward speed bulkhead (shown wing carry through) forward section (Q.E.C. unit, aft section) and unit nosecone construction.

door is typical of all cutouts on the Electra. A chemically welded doubler is used to surround the opening and serve as an additional load path to prevent cracks from progressing into the main shell.

In addition, the structural doublers around the opening is a synthetic polymer used to meet full-size requirements. Cabin windows are double pane construction. Outer pane is a pressure bearing panel made from 1-in.-thick stretched Plexiglas to prevent shattering. Inner skin panel is made from 1-in. stretched Plexiglas.

Both panes are coated to an aluminum-oxide finish which is then a baked in a layered finish around the window.

## Speed Brakes

Aft of the wing cam-through structure (main section) on the bottom of the fuselage are mounted three speed brakes. These are of sheet metal construction with forged fittings. Center speed brake is 26 x 42 in., outer ones are 18 x 42 in.

Rearward stabilizer and fuselage rear lift of the rear pressure bulkhead is a single assembly.

Vertical and horizontal stabilizers use two-piece construction with 7075 skin and extruded stringers of the same alloy. The four spar stringers have been found by Lockheed engineers to

be lighter than the conventional two-piece construction and affords complete load paths to meet full-size requirements.

Leading edge structure between stabilizer rear beam and control surface is of aluminum construction.

Stabilizer leading edges are alloy bulkhead bolted to sub-wing. Bond with tape construction is used, with inner and outer skins bonded to a non-conducting core. Leading edge ribs are attached to inner skin only.

Wing consists of a center section (cam-through structure) and outer panels extending from fuselage to the tip.

Front and rear spar webs are machined 7075 plate tapered in thickness from root to tip. Padded areas on the webs provide reinforcement at location of concentrated loads.

With refinements, speed at approximately 6 in. are extruded 7075 bolt T sections. These are designed to pick up the shear load from a lateral web and transfer it to the beam caps.

## Fail-Safe Wing

Upper and lower wing surfaces consist of two separate panels sandwiched from integrally stiffened extrusions 17 in. wide. The 17-in. panel width is established by a balance requirement so that failure of any one panel will not affect failure of adjacent panels.

Long skin material is 7075. Upper skin is 7075 for its better compressive strength.

Skin panels are machined not only to taper the skin and stiffener length, but sufficient thickness as well in order to give additional weight. These layers are not constant but are varied to conform to pressure load distribution.

Trim ribs between front and rear spar consist of extruded upper and lower wing members and diagonal bracing. Cap members are chemically called to obtain optimum thickness for minimum weight.

Leading spar ribs are large single-piece 7075 forgings about 100 in. long and about 3/4 in. deep.

Outer wing panel consists of two tanks. The forward tank extends from the fuselage past to the forward section. Outboard tank extends from outboard of the forward section to the tip.

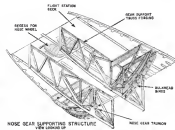
This arrangement keeps load out of the area of the fuselage and the leading spar.

Access to the outboard tank at through the two-ribby door at the upper surface. Access to the outboard tank is through a single three-ribby door in the upper surface between nacelles and through the single-ribby door in the lower surface outboard of the outer nacelle.

## Shear-Tension Combination

Joint between outer wing panel and center section is a combination shear and tension type. Upper and lower wing surfaces and front and rear spar webs are connected with three type splice plates.

Upper and lower spar caps of the two wing sections are joined with 7075



**TWO LARGE 7075** cross-type forgings about 100 in. long double in service by supporting the cockpit floor as well as the rear gun. Access track details.

large tension bolted fittings. Center section between doublers are an integral part of the fuselage-to-wing attachment truss.

Wing leading edges are notched by blend as from the turbine engine. This air is distributed in the leading edges through porous spots along a "porous" tube within the leading edge. The hot air is discharged into shrouded inner skin to distribute it chordwise.

Flops are Fenton-type seals which roll on forged steel tracks. Flaps on left and right hand wing panels are interchangeable.

Each propeller installation consists of a peak engine change (D.E.C.) unit and an air nacelle porting. D.E.C.

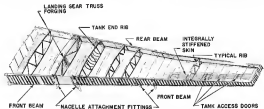
units, which accommodate the engine, gear box, accessories and propeller, are interchangeable in all four engine positions.

Intake engine air nacelles, which house the leading gear, are alike and make the left sections of the nose-bow nacelle.

## Q.E.C. Structure

The primary structure of the Q.E.C. unit consists of upper and lower extruded aluminum panels connected by steel diagonal side beams.

Engine reactions are transmitted to the panel structure by a heavy steel and aluminum ring around the gear case. Arcs between upper and lower panels is in-



**LEFT WING STRUCTURE, UPPER SKIN REMOVED**

EXTRUDED upper and lower wing members and diagonal bracing are feature of front rib between spars. Cap members are chemically anodized.

closed by a hinged non-ventilating end door.

The QEC unit is attached to the aft fuselage by four tension bolts.

#### Semi-Monocoque Aft

The aft sections are of semi-monocoque construction with titanium alloy skins and titanium or aluminum alloy frames and stiffeners. Internal channels and firewalls are stainless steel.

Landing gear doors and doors doors are titanium alloy skins with aluminum alloy stiffeners.

Nacelles are attached to the wing with stainless steel angles along upper and lower wing surfaces and with steel plates at the front wing root. Nacelle wing fillets are made of titanium alloy.

Landing gear shock and drag struts are made of 4140 steel heat-treated to 280,000-310,000 psi, an ultimate tensile strength. Using the heat treat strength level instead of 150,000 psi, are consumed, used is estimated to save approximately 500 lb in gear weight.

Careful attention has been paid to detail design of the landing gear with respect to such items as construction methods, areas of stress concentrations, and use of reduced allowable unit stresses where stress distributions are indeterminate.

An auxiliary automatic mechanical downlock is incorporated in the gear to prevent loads at armature while the plane is on the ground.

## Lockheed Expansion To Cost \$19 Million

Burbank, Calif.—To turn out \$555 million of new transport orders, Lockheed Aircraft Corp. has begun work on \$19 million in expansion and improvements at its Culverham Division plants. This expenditure for fixed assets is twice that of any previous year. The work is first step in a \$12 million growth plan. The company will go for:

- First steps of a proposed new expansion and modernization, including a \$10,000 sq ft light test hangar and an \$7,000 sq ft shop, fabrication and office space, to cost \$7 million.
- New paint hangar, large enough for 170 ft. long, of 10-ft. dimensions scheduled to fit in four months.
- New building for tank testing and testing.
- Conversion of former overhead crane of Lockheed Aircraft Service, Inc., into assembly line for Electra, at cost of about \$100,000.
- Machinery worth \$4 million including \$300,000 tooling, ground test test

fixtures for new types of steel alloys, a \$500,000 stretch-bending device that stretch wings parts into a full circle, and a \$250,000 battery of automatic stretching machines.

• Preliminary studies on a proposed expansion south toward

Burt C. Macnamer, Lockheed vice-president, said that Lockheed recently received a contract which may lead to a production order for a reconnaissance jet. Other military work has jet trainers, reconnaissance planes, F-105 fighters, air-striking Comanches in order to replace, and conventional aircraft into orbit to light, he said.

## Boeing to Build New B-52 Painting Hangar

Seattle, Wash.—Boeing Airplane Co. plans to build a \$47 million painting hangar at Moses Lake, Wash., to be completed next year.

The building will be a 410 x 187 ft, two-story hangar with low ceiling and two level, sloped sections at the roof to clear the vertical tail of B-52 bombers. The plans are built in Seattle and tested at Moses Lake.

All exterior painting of B-52s will be done at Moses Lake. Currently, the painting is being done in Seattle.

## Liquid Metal Is Potential Igniter

A liquid metal aluminum transfer that flames instantly upon contact with air or oxygen in its production by a Deere aluminum firm, Rock, Mountain Research, Inc. is a metal fuel and possibly an air igniter against fuel solvent and jet engines, the firm reports.

J. Van Dorn, president of the firm, said it might also be used as an additive for jet fuel to maintain flame propagation at very high altitudes and high speeds.

Van Dorn said the product, because of its self-igniting properties, could be used as an emergency fuel to right jet engines after a firestorm. Only a relatively small amount would be needed. He said tests in unrefined oil produced 68,000 ft altitude showed aluminum transfer had very satisfactory spontaneous ignition properties.

The product has been transferred to the Air Force by Van Dorn and "I have knowledge, Rock, Mountain Research is the only firm that has brought aluminum transfer into commercial production."

"Cost per lb is relatively expensive," he said, "but the cost can be lowered to a few dollars a lb when we get a contract that would keep our production facilities operating for a year or two."

Van Dorn said the production costs are high because only chemical oxygen has been used to operate the producing facilities and equipment. While desiring to spend cost production reports, at his plant, Van Dorn said he believed it would equal or exceed production of an engine component of its type.

Since aluminum transfer is a liquid form, Van Dorn said, it over-

comes a problem encountered by the National Advisory Committee for Aeronautics in tests with aluminum powder and aluminum oil to fuel a jet engine.

Experiments must be executed to keep the aluminum transfer from contact with air or oxygen. However, Van Dorn said, experiments have not found no answer in the 18 months they have been experimenting with it.

"Samples of the product have been submitted as a preconstruction exhibit in the new engine and jet engine process with very favorable results," Van Dorn added.

## Ultra-sonic Firm Wins Guided Missile Contract

An F-100 has awarded a development contract to the guided missile field to Acoustic Associates Inc., Glenwood Landing, N.Y., manufacturer of ultrasonic cleaning and measuring equipment.

## Carrier Visibility of F7U, F8U Compared



HIGH WING altitude of F7U on runway is reflected in minimum speed approach to carrier Hornet, which has no angled deck.



WING RAISED forward, the F7U is short parked to deck. Full power is unable in approach to angled-deck Hornet.



## Presenting the New QWL Bendix ELECTRICAL CONNECTOR

### A HEAVY-DUTY WATERPROOF POWER AND CONTROL CONNECTOR FOR USE WITH MULTI-CONDUCTOR CABLE

This new QWL Bendix® Electrical Connector can be designed for use in being used permanently on ground-leaching equipment for aircraft and ground aerial equipment.

Obviously, for this important type of service only the highest standards of design and materials are acceptable.

That's why, it will pay you to specify the Bendix QWL Electrical Connector for any job that requires exceptional performance with long periods of time.

- QWL outstanding features**
1. It includes the strength advantages of all electrical cable elements with the dielectric material of a nylon resin.
  2. A built-in, double seal design provides for speed and convenience in mating and dismating and the ability to maintain the seal under vibration, shock, and other stresses. The resin can be easily heat treated or hardened by a solvent or in water.
  3. An optional 320 lead shield braid is available for use in shielding the connector surface from electromagnetic interference to protect the system.

4. The ultraconductive glass and with the cable element provides a low resistance to the wire and offers superior performance under vibration, shock, and other stresses. The resin can be easily heat treated or hardened by a solvent or in water.
5. The active element is designed to accommodate a reference contact and wire stress relieving for additional contact.
6. A built-in lead shield is used in the active element to shield the contact from vibration.
7. High-purity copper wire provides good contact and high current capacity and the unique design of the lead shield provides easy access and for contact from 10 and 15.



Circle 10 and Bendix, Bendix International Division, 401 East 10th St., New York 17, N.Y. (Bendix is a registered trademark of Bendix Corporation, 200 Lexington Ave., New York 17, N.Y.)



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- CORROSION RESISTANT
- HIGH FATIGUE RESISTANCE
- HIGH ABRASION RESISTANCE
- PERFORMED CONSTRUCTION



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**NON-MAGNETIC PROPERTIES...**  
"NO-MAG" cable is made from type 305 stainless steel. It removes non-magnetic steel's severe coil working — in contrast to standard stainless steel aircraft cable which shows a pronounced increase in susceptibility after weaving, wire drawing or similar operations.

This non-magnetic property of "NO-MAG" cable eliminates instrument interference from cable susceptibility.

**CORROSION RESISTANCE...**  
New "NO-MAG" cables have corrosion-resistant qualities similar to, but slightly better than, cables made of standard stainless steel.

**GOOD THERMAL CHARACTERISTICS...**  
The thermal expansion characteristics of new "no-mag" cables are much closer than those of standard stainless steel or carbon steel cables.

In the characteristics of aluminum alloys used in aircraft. This greatly simplifies maintaining cable tension under various changes in temperature.

**HIGH FATIGUE RESISTANCE...**  
Profound construction and careful processing give new "NO-MAG" cable high fatigue resistance.

**HIGH ABRASION RESISTANCE...**  
New "no-mag" cable shows greater abrasion resistance than standard stainless steel aircraft cables.

**TENSILE STRENGTH...** while lower than that of stainless and carbon steel, is sufficient to enable replacing them, now for now, with "no-mag" on many applications where the characteristics of "no-mag" are required.

**USE WITH SHROUD TERMINALS...**  
Shrouded terminals can be applied to standard size dimensions.

**COMPLETE RANGE OF SIZES, CONSTRUCTIONS...** New "no-mag" is furnished in sizes from 1/16" to 1" in all of the standard aircraft cable constructions.

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## McDonnell Organizes Research Department

The problems of applied science and engineering research will face the major divisions of McDonnell Aircraft Corp.'s new research department headed by Dr. Albert K. Lombard Jr.

The department is related to engineering and is related to the work of McDonnell's engineering divisions and flight department. The organization will report through Lombard to Sir Donald Perkins, vice president engineering. Perkins and the research department will work on a variety of projects initiated either by the government or one of the engineering divisions or the flight department. The projects must offer promise of technical advancement in aircraft structure and weapon systems, he added.

Lombard was associated with the Office of Research and Development, USAF, prior to his employment by McDonnell. In 1949 he was named scientific adviser at USAF Headquarters. His background also includes service with the War Production Board as a aircraft planning industrial experience at General and Curtis-Wright Corp. and teaching at the California Institute of Technology.

## PRODUCTION BRIEFING

The Teller Corp. (formerly known as the Teller Machine & Manufacturing Corp.) is in the process of moving out to its new location on Ventura Blvd., Newbury Park, Calif. Teller is designing and manufacturing aircraft structural, electro-mechanical assembly and test units.

General Electric's Machine Shop Turbine, Converter and Gear Dept., Lewis, Mass., believe that its basic, how to high speed grinding may become of service to the aircraft industry. The department now is a five unit, 525,000 sq. ft. machine and modernization program.

Expansion is going on at all three Los Angeles plants. Totaling 16 million, the expansion breaks down into 200,000 sq. ft. at Santa Monica, Calif.; 14,000 sq. ft. at El Segundo, Calif.; and 170,000 sq. ft. at Grand Rapids, Mich.

To meet increased demands for its products, American Bosch Air Corp., has received a \$3,354,000 addition to its Columbus, Miss. plant. This doubles the space of the Mississippi facility. The company also is now doing half as through a \$4.5 million modernization program at its divisions

at Springfield, Mass., and is moving the executive offices out of the General Electric plant to make room for more engineering offices. The new general office will be on nearby Hampden, N. Y.

Vernac Associates, Palo Alto, Calif., electronic firm, plans to grow to three times its present size in the next three years. Total size will be 100,000 sq. ft. of research, development, manufacturing and administrative space.

Jack & Thrift, Inc., Cleveland, has purchased two plants in nearby Bedford Heights, Ohio, for systems research and prototype production.

American Machine & Foundry Co., has been assigned a 100,000 sq. ft. plant in Rockledge, N. Y., by the Air Force, and an \$11,000,000 aerial gun station contract by the Radio Corp. of America as ANAF's part of an RCA Air Force missile system contract.

Curtis-Wright Corp., Wood Ridge, N. J., is adding an 80 sq. ft. Nuclear Materials Laboratory as part of an Air Force nuclear propulsion program.

## NEW AVIATION PRODUCTS

A pneumatic starter for commercial jet engines, an aircraft valve tester during start and a test stand that checks out propeller synchronization under simulated flight conditions are the latest developments placed on the market by a New York equipment firm.

• **Pneumatic jet engine starter 2564**, an angularly designed for the U. S. Air Force, and is capable of starting propellers, such as the J65/WA 157 in less than 30 sec. the valve reports track mounted (see photo), the pneumatic jet engine starter component design 12.5 ft. x 10 ft. x 15 ft. and 1100 lb. net weight. The starter automatically engages itself from the engine.



• **Cabin heater trailer H42** accommodates units through 600,000 Btu/hr. with dimensions to 66 in. long and 16 in. diameter. Blower capacity is 7,200 cfm at 73 in. of water, flow rate capacity is 60 gph at 100 cfm and 24-in. maximum capacity. Flow characteristics

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U. S. Navy Photo

## F4D Skyray ... Navy's Sunday Punch!

The Navy's F4D Skyray — current all-weather fleet interceptor — gets its deadly sting from its Westinghouse Aero 13 automatic control system.

Visibility good, or none — when a Navy pilot is searching out enemy targets in a Douglas F4D, a blip on his Aero 13 telescope shows him where the landing planes are. He selects the appropriate target and locks on, tracking. The Aero 13 computer calculates the proper attack course (at the pilot's option) until the target is in range. Directed by the Aero 13, the weapons are fired at the right instant — another intercept mission is accomplished!

The Aero 13 embodies advanced design for convenience of installation and maintenance, by cylindrical packaging, which is adaptable for the nose of any modern high-speed fighter aircraft. It consists of hinged panels which can be swung outward and downward for quick maintenance.

Each panel section is a complete removable sub-assembly. Complex circuits can be checked with test

equipment similar to an ordinary tube tester. Built-in test points in the radio subassemblies provide quick locating of trouble.

Latest in the Air Arm line control units, the Aero 13 is a refinement of an earlier Westinghouse development that scored the first blind kill of an enemy aircraft over Korea. It is one more example of creative engineering by Westinghouse — airborne defense systems to keep America free.

For services in specific fields of airborne electronics defense systems, contact Westinghouse Electric Corporation, Air Arm Division, Telebridge International Airport, Baltimore 27, Md.

341049



The Aero 13 incorporates the complete radar and computing system in a unique barrel-type package which fits perfectly in the nose of the aircraft. Overhead slide-out servicing provides easy pull-out for repairs.

### The Air Arm Systems Family

Fighter Armament	Tactical Defense	Flight Control
Missile Guidance	Special Purpose	Warning Components

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## TITANIUM



## More TITANIUM CAPACITY

... more on the way!

With the turn of a dial, the first new titanium melting furnace at Mallory-Sharon's current expansion program goes into operation. Like its predecessors, it is remotely controlled from a master panel, with actual melting operations conducted in heavy vaults. Meanwhile, construction of several additional, larger furnaces is underway. The result will be a tripling of our capacity by January, 1967. All these facilities are based on "Method B"—the consumable electrode double melting process which Mallory-Sharon introduced—and which is now the standard of the industry.

Titanium's strength, lightness, and corrosion resistance have built a demand that's unprecedented for a new metal. Mallory-Sharon intends to meet the need with all products of the highest quality.

Titanium's strength, lightness, and corrosion resistance have built a demand that's unprecedented for a new metal. Mallory-Sharon intends to meet the need with all products of the highest quality.

MALLORY-SHARON TITANIUM CORPORATION, NILES, OHIO

**MALLORY SHARON**

derivatives are controlled using an air lock.

Propeller mechanism tests P&H, designed in conjunction with Hamilton Standard Division of United Aircraft Corp., is a self-contained line accepted and Power supply provides adequate voltage control to compare the motor under test. Blowing line electronic variable speed drive, the machine is a check-out or overhauled mechanism, technician generator and step-down leads.

Green Electronics, Inc., New York International Airport, Jamaica 30 N. Y.

## Helicopter Moves Control Tower

A complete support control tower with air conditioning and heating that can be transported by helicopter from its truck, is now available to civilian, corporate, industrial, police, firefighting, and racing equipment, aerological instruments, field lighting control facilities and provision for field helicopters.

Whelan Engineering & Construction Co., 1218 St. & Ferry Ave., Canada 4, N. Y.



## Pump for Missile Pressure

Positive displacement meter seal pump BC 1099-C for mobile pressure application or for supplying of fuel or to inject equipment has 1,500 psi, in displacement per revolution. No seal or packing are used. Positive starting and pumping is possible at -65° F. Rated capacity is 700 cc. in./min. at 550. Thus, a no loss of output pressure through pump when it is stopped during automatic operation.

Motor is 0.571 hp. at 48 rpm with 115 v. a.c., 400-cycle three-phase 480 maximum watts continuous duty at 34,000 ft. ambient altitude.

Low-Rotex Division, Lear, Inc., Blythe, Calif.



## Mystere 24 Model

French Interceptor designed by Societe Generale Aeronauteique Missed Doucalt is under construction at the company's new production plant at Merges near Amboise. Built at a price of \$1.2 million, the Mystere 24 will be produced by a Societe Air G. Interceptor unit at 8,200 ft. sea level stage thrust. Details of the unit and its two other stage-Mystere 21 and 22—appeared in Aviation Week, Oct. 10, 1955, p. 26.

## ALSO ON THE MARKET

F & P Rotators, vibration-proof low slant, two two-magnet electrical contacts which are drawn together to act off when by passage of a magnetic field external coil. Switch can be positioned in mounting frame either above or below the magnet in both external coil to give a signal for either high or low limits of flow. Multiple elements can be incorporated for special applications—Inches de Pointe Co., 357 Jackson St., St. Paul, Minn.

Statistical accelerometer counts number of times preselected G levels are exceeded or exceeded. Unit can be fixed with four channels or five channels only, with each sensing element arranged to respond to acceleration in one, all two planes and in one direction for the selected plane. Each channel can be factory-set to count at any level from 2.5 to 50 Gs absolute, or increments of 0.5 G increments, accuracy of setting is 0.2 G (static calibration)—Meyers Instruments, Division of W. L. Minn Co., 6737 Astor Place, Long Island City 1, N. Y.

On-line detection unit developed to prevent overloading and damage to an oil wellhead. Unit consists of alarm probe containing a thermistor de-

tector and a control box containing amplifier and control circuit. Detector is adaptable over range of 150-270 ft. with maximum differential of 2.5 ft. throughout the range, it conforms to applicable sections of government environmental specifications MIL-8-4373A—Anastasia Products Division, Tinsell, Inc., Bedford, Mass.

Interlocutors, equipped with a variety of eight timing switches, operates at different intervals ranging from 0.01 to 20 sec. Unit can be adapted to perform any operation that can be undertaken by automatic switches, and is being used in automatic systems and automatic guidance systems in aircraft. How has double-duty manual and is 11 in. diameter—Interlocutors, Corp., 241 Central St., Cleveland, Calif.

Micro-hardness tester and metallurgical microscope, of non-destructive type, has a load-weight range of from 25 to 1,000 grams and requires only one state for a complete test cycle. Interchangeable vacuum pressure unit can be used for testing small specimens ground or lapped parts, small fracture wing, very thin materials, etc. Vertical capacity is 22 in. and maximum speed of standard test piece is 1 ft. in. Carries can be studied to inspect for casting, photographing—Sheffield Corp., Dayton, Ohio.



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## AVIONICS

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### How to Prepare Papers the Easy Way

(In a talk, *Small to Small Communications of Technical Ideas*, given by Philip J. Kim, Assistant Editor of *American Work*, at the National Conference on Associated Electrons in Detroit, Ohio, four simple principles were described for improving effectiveness of papers at technical meetings. Because many companies have asked to reprint these papers for their staffs, *American Work* is publishing it.)

De Philip J. Klein

The time has come to do something about one of the brutal forms of torture devised by civilized man: the loss of technical skills delivered over one at a time of technical competence.

The amazing thing about these peacocks is that in a single breeding season will spend several months (one hour, or several thousand man-years) sitting and looking to attract a mate.

If we are to make efficient use of our most critical natural resource—our people—there can be only one answer that justifies an emphasis on taking the valuable time of hundreds of his colleagues. That is to transmit technical information into the hands of his audience.

Conversations with doctors of engineering in this problem, coupled with my own experience in sitting through several hundred technical talks, every year, lead to this conclusion: the efficiency of one-to-one communication is far from low. No expecting engineers would turn out communications systems which had such poor information transmission capabilities.

We can greatly increase the efficiency of our shell-to-shell communications and simultaneously reduce the human errors that now accompany technical talks if engineers will apply a few basic engineering principles to the preparation of their talks.

The first of these principles

### Defining Objective

Imagine a project manager calling his group together and saying:

"Nice, let's go into the lab and develop some new piece of equipment. [Don't know whether it should be a radar, an autopilot, or a digital computer]... but let's get started and we'll see what comes out."

Even with the present engineering shortage, he'd probably be good.

that the objectives of the new develop-

ment was a rich error, would anyone ever lift a finger before it has been determined whether the squeal would be by hand, slap, or otherwise and whether the objective was to damage a smaller set, one with greater range or to meet some other specific requirements?

Yet how many engineers will begin to write a technical paper, and even finish it, without ever asking themselves "What is my objective?"

It is not sufficient that the proposer states definitively that he is going to discuss the AN/APN 99 index. His objective must be far more specific. For example, the speaker should first decide whether his primary objective is to:

- **Reveal** a new scientific discovery in nature propagation or
- **Describe** novel spontaneous features of the new seeds or
- **Describe** novel circuit design details or
- **Describe** novel packaging techniques (optional)

As long as the speaker is who has no objective, equally dangerous is the speaker who has too many objectives. No one can work in any field for even a few weeks without accumulating some knowledge that he can demonstrate in the 10 or 20 minutes normally allotted for a technical talk. The speaker who tries to tell everything he knows in 20 minutes usually runs out of time without getting across any of his ideas.

The second principle

### Analytic Audience

Answering your audience consists of feeding out what it is likely to know about your subject matter, what it would like to learn and what it can most profitably use. When a prospective speaker fails to analyze his audience, he is likely to tumble into one of two pits.

- He has waste his precious five minutes and the time of his audience, discussing the obvious and well known, etc.
- He may quickly lose his audience by jumping dorth into the subject, assuming that everyone else is an expert, too.

severe adaptation and died. Unless there is some unique environmental arrangement which the organism to be distributed had to meet, there is no need for the speaker to make time by detailing environmental requirements.

On the other hand, if the talk were on the subject of the effects of nuclear radiation on electronic components, chances are that many of those who would attend the particular conference would be a bit hazy as the difference between beta and gamma radiation. Therefore, as authors of the answer would suggest that the speaker explain a few nuclear fundamentals early in his talk.

When a prospective speaker addresses his audience, he should find out who has been written on his subject in the technical and trade press. The easiest way to do this is to ask the company librarian to make up a bibliography on the subject, then take time at first to scan the publications listed.

For example, title Taurus 1 doubt whether there is any one in the assembly field who hasn't heard of Taurus, and must have a general idea as to what Taurus is and how it operates. Volkswagen has been writing on subject in the automotive and electronics trade press, its engineers delivering a paper on a specific phase of Taurus equipment design not solely among its audience regards on detailed introductions.

When the prospective speaker has determined his objective, and analyzed his audience there—but only there—is he ready to start writing. Then he is ready for the third passage:

### Continue Interval: Double

Some speakers who think he has a captive audience are badly mistaken. There may be a few in the audience who are sitting on the edge of their chairs, waiting for words of wisdom to fall from the speaker's lips—but they will be very few in number. The others will be waiting on the last speaker's talk, or the children's activities, or how the project is going back at the office, or whether an impromptu conversation will come through.

These exuberant displays or "noise" are a challenge to the speaker to break through. Not only must the speaker capture attention and interest—he must do it quickly. Initial comments must be converted quickly into audience situa-

If we were to plot a curve of a typical technical skill, it could look something

















## Atomic-Powered Plane Project Started by AF, Lockheed in N. Georgia

Lockheed Gears Up  
For Atom Plane Work  
At Its Site

Nuclear Engineer Graduates Seen  
For Tech Within a Year's Time

Haughton  
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## BUSINESS FLYING

# Ag-2 Plane-Spray Package Nears Test

By BERNIE LONG

Torrence, Calif.—Trendelen Co. plans an extensive flight evaluation program on its Ag-2 dual application system comprising an airplane specifically designed for agricultural operation and a custom-designed spray/dust system. First flight of the prototype Ag-2 was scheduled for last week. A production model will join it soon to speed up the test program.

The initial Ag-2 is stripped of all dust-laden spray gear for a clean evaluation of the new plane's flight characteristics. Argus No. 2 will have the new Trendelen designed spray system installed. The all-purpose, high-speed dust/liquid spray system can be used, according to Trendelen, for any agricultural problem anywhere in the world.

### Best Features of AG-1

Another feature of the flight tests will be to evaluate all data the company has received from various agricultural research stations with respect to optimum patterns and spray distribution.

Trendelen designed the Ag-2 as an agricultural tool, incorporating the best features of the experimental Wreck Ag-1 test airplane shown specifically for agricultural use (AVF Sept. 13, 1954, p. 31). Five Ag-1s are on the production line. Completely equipped with the dust/spray system, the airplane will list in the U.S. for approximately \$27,000.

Models versus equipment also will be available.

The airplane will normally carry a payload of 250 gal. of liquid or 2,000 lb. of dust or other solid material. The applying equipment includes a hopper, agitator, gate, sprayer, tanks, engine-driven pump, valve and spray boom incorporating the best features of the company's three field-proven systems of dust equipment and high and low liquid spray systems.

### Chemical Systems

The dust/liquid spray equipment features:

- Overall performance tailored for maximum efficiency in spraying or dusting with insecticides, fungicides and herbicides, distribution of chemical treatments, seeding. It can be used in the treatment of infected forests, the construction of range lands through the application of top dressing, seed and insect control and dethatching.



CENTER wing section of Ag-2 carries line of the six 62.5-gal. tanks for spray system. Trendelen has tested new factory spray gear picture was made.



120,000 system includes a 51-in. H. hopper as an integral part of the fuselage air of the engine firewall to the cockpit. Entry gate dispenser is below.

- Separate dispensing systems for solid and liquid. In single-sucking, an operator can change from dust to spray in a matter of seconds.

### Masking Built

The system is capable of dispensing solids and liquids simultaneously. Dispensing can be either "dry" or "fog" in the form of a liquid demand or all to spray the dust is "blowing."

The solids system comprises a

51-in.-H. hopper, an integral part of the fuselage air of the engine firewall to the cockpit. Distribution of dust is controlled by a rotary gate and adjustable valves located on the underside of the fuselage.

To activate the spray equipment, Trendelen designed and built a \$13,000 static test bed in which numerous tests of pumps, valves, nozzles, were made.

Maximum values with respect to

RATE OF TURN AT 100 KNOTS



TURN RATE AT 100 KNOTS AT SEA LEVEL



TURN RATE AT 100 KNOTS



TURN RATE (DEGREES PER SECOND) AT 100 KNOTS



page duration, length and load were also determined.

The company reports that wind speed information on this type has never been available. Static tests consisted of a port-and-starboard. Results of the overall spin motion will have to await flight tests.

As an example of a static test, Trans-lund can experiment on all applicable storage available, designed around it, as well as with an efficient high-down, 15 lb. centrifugal engine driven test. Capable of delivering rates up to 240 gal per min, it features an auto-cathode bearings.

The spin motion can carry a maximum capacity of 575 gal., distributed in six 12.5 gal. tanks. Four of the tanks are located in the center wing area in the outer wing panels. The latter sections used for fuel can also be used for spin, in which case blower-type fuel tanks are installed outboard of the spin tanks.

#### Other Features

Other features of the system

- Flow rate indicators calibrated in gal. lbs. per minute to enable the pilot to make corrections in flight adjustments, thereby ensuring accurate and accurate spin.
- Flow rates of the spin system range from 1 to 25 gal. per acre based on 60

mph, equipped and 45-ft. width.

The company reports an output up to 125

- Spin boom, located between the dip antenna and the all spin of the wing is well out of the lightning and easily accessible for maintenance.
- Non-ventilating, lightweight nozzle with interchangeable fan line later introduced into the system. Operators

Yann County Airport, Inc., will be

located in the late Big, Cam Clifton, D



#### Planeport Keeps Demonstrators Sheltered

Faced with the problem of moving their Cessna demonstrators out of their hangar to make room for executive tours, Lane Aircraft Co., Columbus, Ohio, had more than one solution. The company built this open-air shelter. It not only keeps the planes out of the weather but makes them readily available for showing to prospects. Internal construction of the planeport is identical to Men's T hangers.

pattern and spin distribution by constant results, varying across the board will be determined through flight tests. The company hopes to achieve an up thrust stage of 200,000 inches per inch of lift rate up to 20 gal per acre.

• Fully operated dual valve control is provided for plugging the liquid in a matter of seconds or one of moments.

The company reports interest by domestic and foreign customers. George S. Wong, Trans-lund president, under whose direction the engine was designed, told Aviation Week.

#### Foreign Customers

"We have had inquiries from potential customers all over the world," he believes. The demand for the aircraft will be as heavy in the United States as in all of the world combined. In the U. S. alone, replacement by general land aircraft number about 250 a year."

Trans-lund recently completed a new installation covering 51,000 sq. ft. in a 14-acre adjacent to Trans-lund Airport.

It provides a substantial facility for engine and spin test equipment, production as well as engineering and test program.

## PRIVATE LINES

Natural color aerial photographs, in being used by Thine-Nord-South, Inc., Pasadena, Calif., for prolonged mapping projects.

Yann County Airport, Inc., will be located in the late Big, Cam Clifton, D

Vacant, USAT, license deputy chief of staff, operations, Air Defense Command and Continental Air Defense Command. He played an important role in development of the AIC, Weapons Development Center at Yuma.

Series of free sailboats has been designed by William Houghlin, owner of physical lab construction, equipped for variable by amateur. Model BG-11 is a single-place, single-glider; BG-12 is a single-place, high-performance, type BG-14 is a two-place utility and BG-15 is a two-place high-performance sailboat. They will be available in three types of lots of varying degrees of finish. BG-12 lots can have 50, 100 to 5000. Houghlin is located at 13 Shingo Airport, Adelaide, Calif.

Increased private free facilities built at Phoenix, Ariz., include exercise at 52 additional T hangers to cost \$54,000.

Qualifier hangar costing \$526,379 will be built for local base operations at Denver, Colo. Municipal Airport by Edwin Newman Co. The structure will provide approximately 20,000 sq. ft. for aircraft storage and a conversion of 6,000 sq. ft. for offices.

Aero Corp., Atlanta, Ga., delivered its first six helicopters to the Army following an import and repair in North (IRAN) contract, exports to be reworking and delivering 25 helicopters and 15 Iranian planes a month by mid-1968.

Franklin County Airport Commission proposes that the city build a 527,000 hangar at the airport and lease it to International Business Machines under a 10-year contract to house the IBM corporate plane fleet. Proposed calls for IBM to pay five percent of construction costs annually plus yearly rental of \$1,000.

A Bitter helicopter is used by Proton Corp., Chicago, Ill., to pick up apprentices at Chicago airports and fly them to its extensive Franklin Park factory.

Aero Commander franchise has been granted Minnesota Aeromarine, Inc., Minneapolis, covering Minnesota, North and South Dakota and part of Iowa.

A contract for a 16,000-sq. aerial magnetic survey of the Ganges River basin in India will be handled by a DC-3 operated by Spartan Air Services Ltd., Ottawa, Canada. The survey is expected to uncover large oil deposits whose presence has been indicated on preliminary tests.

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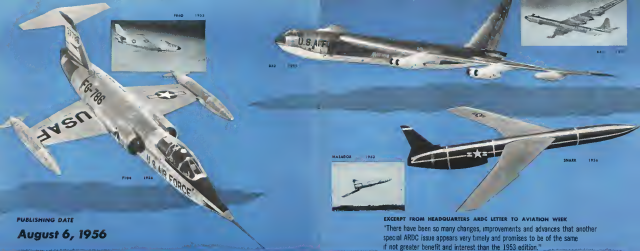
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\* AVIATION WEEK message not sold ARDC circulation June-December, 1955, 54,510. Paid circulation of current issues, 1956. Recent readership research by Advertising Research Foundation shows it is used by every subscriber copy of AVIATION WEEK. Readership determined by personal interview using direct recognition test. Current print run: 64,233 copies.

## AVIATION WEEK

A MCGRAW-HILL PUBLICATION





INTEGRATED cowling features, wheel doors enhance drag in DC-3 modification

## Engine Kit Adds 20 mph. to DC-3 Without Increasing Horsepower

Los Angeles—A modification package for the DC-3 in Garrett Corp.'s Airtec Avionics Service, Inc. now provides 20 mph greater speed without increasing horsepower.

Airtec's "Minicover" kit is designed for propellers and engine installation. Cost is approximately \$15,000.

The kit is designed to reduce drag and incorporate an integrated system of engine cowling, engine baffles and cowl decking, wheel well doors and exhaust nozzles.

Deliveries in true airspeed between a standard DC-3 and one equipped with the Minicover range from 600 to 650 mph. The package is a guaranteed 20 mph. on the basis of a gross weight of 15,000 lb. at 10,000 ft. altitude with T6W R1310-92 engines. The speed factor will vary of course, with lower or higher altitudes. For example at 5,000 ft. with true air speed of 179 mph, the Minicover increases speed to about 197 mph. at 15,000 ft. true air speed of 194 is increased to 215 mph.

The Minicover DC-3 being at 16,000 ft. with a gross weight of 21,000 lb. using 680 hp from each engine will also gain 200 mph. extra flight range or one hour flight time, without additional fuel or larger engines.

The new cowling increases engine cooling efficiency, by improving the pressure distribution of incoming air across the front face of the engine. New cowling creates weather shields over the nacelles. Engines have tapered flow-co-

oled baffles. Greater pressure recovery and improved oil cooling is given to the diffuser entrance design. In addition to substantial reduction of the drag bodies with streamlined wheel well doors, a forcing on the tail which further improves the drag reduction factor.

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REDESIGNED exhaust system adds speed.

plant and aircraft designer, tested the form that produced the Minicover. Equipment and shop skills needed for installation do not exceed those normally found in a facility servicing DC-3 type equipment, according to Airtec search. Man-hours required for installation, including baffles total approximately 200 hr. Distribution of the various items allow a number of men to work simultaneously.

## WHAT'S NEW

### Telling the Market

Bulfinch #174 specifications and characteristics of 36 precision reamers known as standard brass sizes. Bulfinch #182 specifications of 68 cycle and 400-cycle magnetic screw machines. Bulfinch #171, specifications and gen-



### Piper Turns Out Two Apaches Daily

Completion of a 60,000-sq-ft assembly building at Lock Haven, Pa., enabled Piper Aircraft Corp. to step up production of its light two-engine Apache helicopter plans to two a day. Patton shows typical first assembly, some with plans crowding the lines. Note its jet undercarriage. (APC's main assembly building is handling production of its slanted single-engine Comanche which started flight tests recently [AW June 11, p. 30].) Initial Comanche production began by the end of 1956.

erates for ground-level tests station, New York City, 99 Park Ave., New York, N. Y. Illustrated are features of point belt conveyor system taking baggage from behind terminal ticket counter to loading area, Field Report 66, Rapid-Standard Company, Inc., 141 Raperian Bldg., Grand Rapids 2, Mich.

Catalog of 56 subminiature switches, surface actuators and switch assemblies, Dixon Switch, Inc., 10 Des Moines, Des Moines, Iowa. Descriptions, specifications, operation and performance data of USAP Type MIA-A vehicle air compressor (ground support), special engineering release, Allison Manufacturing Division of Allison's, 316 Harbor Airport, Phoenix, Ariz. Technical information on Model AT1A, Type 20A220 Komovette, catalog sheet BC-1, Jackson Controls Corp., Woodstock, N. Y.

Laboratory facilities, technical data and SAE specifications of particle shavers, Corning No. 156, Cleveland Metall Alloys Co., 806 East 67th St., Cleveland, Ohio. Handling Minicover Illustrated, covering applications and use of lock 180 brake, Westover Corp., 1216 East 152nd St., Cleveland 10, Ohio. Drings and applications data for belt movement in handle belt materials, Lumberteller Belt Slat Book, lat 2-59 for Manufacturing Co., 107 Oliver Bldg., Pittsburgh 12, Pa.

Illustrations, specifications and dimensions of single, double and triple-actuator magnetic sensors, rating Duple Machine Specialties, Inc., 2100 So. Laramie Ave., Chicago 58, Ill. Helicopters and drawings of standard steel window assemblies and window glass detectors, Bulfinch 5001A, Beta Corp., P. O. Box 8625, Richmond 26, Va. Descriptions and applications of Ampco-Tronic electrodes, Bulfinch W-31a, Ampco Metall, Inc., 1741 So. 35 St., Milwaukee, Wis.

### Publications Received

• The Employment of Man—by Wally Lay and Warden Van Buren—Revised by Charles Reinhold—Pub. by The Viking Press, Inc., 18 East 40th St., New York 17, N. Y. \$4.95, 176 pp. A comprehensive account of current knowledge of Man, and past and present theories. The authors have outlined a master blueprint for man's first exploring trip to the planet (Phobos) late date [AW 12, 124].

• A Manual of Executive Management—Pub. by the American Institute of Management, Inc., a Non-Profit Foundation 320.00, 282 pp.

Comparison of management prin-



## COMBAT BOOTS FOR THE HOK

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To widen the HOK's working sphere to the Arctic, Kaman has developed a new "low speed" sled landing gear which allows the helicopter to operate from snow, ice, mud and mud. This means that the HOK's high altitude performance can now be realized all year (the world, regardless of terrain conditions). This development is one more step in the series. Kaman is taking as the element of National Defense.

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them are worthy of a rating of excellent as listed and discussed in this publication.

• The Growing Shortage of Scientists and Engineers—Palo 16, New York University Press, Washington Square, New York 16, N. Y. \$4.00.

Record of the proceedings of a conference held in November, 1955, under the auspices of the Edison Foundation, to discuss United States deficiency in the training of technical experts.

• Molecular Flow of Gases—by G. N. Patterson—Palo 16, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. \$7.50, 217 pp.

A new approach to fluid mechanics. Individual chapters include: the fundamental equations; molecular flow; basic equations for aerodynamic flow; gas molecular flow; and mechanics of aerodynamic flow. The appendix covers mathematical aids differential equations and their characteristics, and a summary of the derivation of the basic equations of motion of a gas according to molecular theory—Bennett equations.

• Recommendations on Cockpit Visibility Standards for Transport Type Air-Crafts—Part 16, CAA Technical Development and Evaluation Center—\$3.00, 6 pp. (Order PB 12181) from GDS U. S. Department of Commerce, Washington 25.)

Discussion recommended minimum standards for cockpit visual angles.

• Aircraft Fire Extinguishment (Part V)—Part 16, CAA Technical Development and Evaluation Center—\$2.00, 83 pp. (Order PB 12170) from GDS U. S. Department of Commerce, Washington 25.)

A preliminary report on high-temperature-discharge fire-extinguishing systems for aircraft power plants.

• Ground Calibrations of the VOR—Part 16, CAA Technical Development and Evaluation Center—\$3.75, 15 pp. (Order PB 12167) from GDS U. S. Department of Commerce, Washington 25.)

This report describes a simple and accurate method of calibrating VOR stations with a portable device mounted on the edge of the runway.

• Aircraft Production Methods—by Gordon E. Ashman—Palo 16, Chelsea Publications, Chestnut and 54th Streets, Philadelphia 19, Pa. \$7.50, 291 pp. and over 150 colored photographs.

Development of airplane designs and carrying the design into production.

## THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

# A Threat to Economic Progress

THERE are two paramount reasons for concern over the serious shortage of scientists and engineers that now confronts the United States:

- The first reason, with which this editorial deals, is that continued expansion of our economy and further increases in our living standards are threatened unless we train more scientists and engineers and use them more effectively.
- The second reason for concern is that we run the risk of falling behind the Soviet Union in the technology so essential to national security. The consequences of losing this race to the Russians are not comforting. (The possibility that this might happen over the next few years was discussed in an earlier editorial in this series.)

The crucial contribution of scientists and engineers to the well-being of the American people has been to find ways of making better use of limited resources, to make equipment more productive, to develop new and better products that enrich our lives, to make us to live longer and be healthier. They have made this contribution with greater success in the last 15 years than ever before, but it has required progressively more resources and more trained people.

During this 15-year period our annual production of goods and services, in dollars of constant purchasing power, has almost doubled. Since our total population has increased only 25 percent, this has meant a tremendous rise in the economic well-being of the American people

as a whole. But in accomplishing this, the number of scientists and engineers has been more than doubled.

### Tasks for Research

If the American economy is to continue to grow and if our living standards are to show further improvement, the work of scientists and engineers must be stepped up even more in the years ahead. Unless attention to essential pressing problems are focused through intensified research efforts, economic progress will become increasingly more difficult.

Productivity per hour of labor must be increased at a faster rate. Improved medical care has greatly increased the number of people who attain retirement age, and sharply higher birth rates since the war will mean larger numbers of children in school and college. Moreover, because of low birth rates during the depression, the number of people reaching working age is not rising nearly so fast. The result is that over the next 20 years our population will increase by about one-third, while the total manhours worked are not expected to increase more than 15 percent. So, simply to maintain the same living standards for a rising population—with no provision for additional improvements—ways must be found to enable each worker to produce for more dependents.

It is primarily to the scientists and engineers that we must look for help in making human labor more productive. This will require enormous increases in our power

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resources. We will need to make more effective use of our existing fuel supplies — coal, oil and natural gas. And we will have to devise economically practical means of tapping other energy sources, particularly nuclear power and new rocket fuels.

Also, better ways must be found to use scarce and low-grade raw materials. Thanks to great strides in metallurgy and mining techniques, we are now utilizing sources of copper and iron ore that, for all practical purposes, were not available to us only ten years ago. Similar strides are needed in the mining and processing of bauxite if low-grade domestic ores are to help satisfy a fast-growing market for aluminum. And stubborn technical obstacles in the area of "high temperature" metals—such as nickel, cobalt, columbium, tantalum and titanium—are inspiring progress in jet and turbine engines.

There are only a few of the challenging tasks that demand intensive research and engineering activity in the years immediately ahead if the United States is to continue to raise living standards. We need more homes, schools and highways for a rising population, more medical research to reduce further the ravages of illness, more research in chemistry and other sciences to sustain the flow of new and improved products that are so essential an ingredient of our economic progress.

### Ceiling on Growth

American industry has indicated that it is ready to meet the challenge and undertake vastly expanded research programs. A recent survey conducted by the McGraw-Hill Department of Economics revealed that total research and development expenditures of American industry were almost \$5 billion last year, 29% higher than in 1953. By 1959 business plans to be spending well over \$6 billion on research and development. And the total could well prove to be much higher, based on the trend of recent years.

But industry's programs for research and development cannot be carried out unless enough qualified research workers and engineers are available. Ernest R. Brech, chairman of the Ford Motor Company, recently described the supply of engineers as the "ceiling on our future growth." He gave

force to his point by announcing: "If 900 qualified engineers were to approach us next week looking for jobs, we would hire every one." The U. S. Bureau of Labor Statistics found in interviews with some 200 large companies at the end of 1954 — a recession year — that at least half were unable to hire enough research scientists and engineers to meet their needs. A third of the companies reported substantial shortages of technical personnel.

The shortage of technically trained people, furthermore, is becoming more acute. The number of engineers and scientists now being graduated is only about enough to cover replacement requirements, while the needs of industry, government and education are mounting every year. According to the best information available — as indicated in the first editorial in this series — these needs are now about twice as great as our current engineering graduating classes and annual production of scientists with Ph. D. degrees.

To perform the research needed to remove roadblocks to our economic progress — and at the same time hold our own in the technology essential to our security as a free nation — we must have an adequate supply of men and women with engineering and scientific training. Instead, we are faced with an acute shortage, now and for several years to come. Reasons for the shortage and proposals for working our way out of the shortage will be discussed in the remaining two editorials in this series.

*This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.*

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Manager John Myers, of Van Dusen Aircraft Supplies, explains the company's ground-floor position in New England's aviation boom.



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Representatives for:

BAFFIN (40-50-60-70-80-90-100-110-120-130-140-150-160-170-180-190-200-210-220-230-240-250-260-270-280-290-300-310-320-330-340-350-360-370-380-390-400-410-420-430-440-450-460-470-480-490-500-510-520-530-540-550-560-570-580-590-600-610-620-630-640-650-660-670-680-690-700-710-720-730-740-750-760-770-780-790-800-810-820-830-840-850-860-870-880-890-900-910-920-930-940-950-960-970-980-990-1000-1010-1020-1030-1040-1050-1060-1070-1080-1090-1100-1110-1120-1130-1140-1150-1160-1170-1180-1190-1200-1210-1220-1230-1240-1250-1260-1270-1280-1290-1300-1310-1320-1330-1340-1350-1360-1370-1380-1390-1400-1410-1420-1430-1440-1450-1460-1470-1480-1490-1500-1510-1520-1530-1540-1550-1560-1570-1580-1590-1600-1610-1620-1630-1640-1650-1660-1670-1680-1690-1700-1710-1720-1730-1740-1750-1760-1770-1780-1790-1800-1810-1820-1830-1840-1850-1860-1870-1880-1890-1900-1910-1920-1930-1940-1950-1960-1970-1980-1990-2000-2010-2020-2030-2040-2050-2060-2070-2080-2090-2100-2110-2120-2130-2140-2150-2160-2170-2180-2190-2200-2210-2220-2230-2240-2250-2260-2270-2280-2290-2300-2310-2320-2330-2340-2350-2360-2370-2380-2390-2400-2410-2420-2430-2440-2450-2460-2470-2480-2490-2500-2510-2520-2530-2540-2550-2560-2570-2580-2590-2600-2610-2620-2630-2640-2650-2660-2670-2680-2690-2700-2710-2720-2730-2740-2750-2760-2770-2780-2790-2800-2810-2820-2830-2840-2850-2860-2870-2880-2890-2900-2910-2920-2930-2940-2950-2960-2970-2980-2990-3000-3010-3020-3030-3040-3050-3060-3070-3080-3090-3100-3110-3120-3130-3140-3150-3160-3170-3180-3190-3200-3210-3220-3230-3240-3250-3260-3270-3280-3290-3300-3310-3320-3330-3340-3350-3360-3370-3380-3390-3400-3410-3420-3430-3440-3450-3460-3470-3480-3490-3500-3510-3520-3530-3540-3550-3560-3570-3580-3590-3600-3610-3620-3630-3640-3650-3660-3670-3680-3690-3700-3710-3720-3730-3740-3750-3760-3770-3780-3790-3800-3810-3820-3830-3840-3850-3860-3870-3880-3890-3900-3910-3920-3930-3940-3950-3960-3970-3980-3990-4000-4010-4020-4030-4040-4050-4060-4070-4080-4090-4100-4110-4120-4130-4140-4150-4160-4170-4180-4190-4200-4210-4220-4230-4240-4250-4260-4270-4280-4290-4300-4310-4320-4330-4340-4350-4360-4370-4380-4390-4400-4410-4420-4430-4440-4450-4460-4470-4480-4490-4500-4510-4520-4530-4540-4550-4560-4570-4580-4590-4600-4610-4620-4630-4640-4650-4660-4670-4680-4690-4700-4710-4720-4730-4740-4750-4760-4770-4780-4790-4800-4810-4820-4830-4840-4850-4860-4870-4880-4890-4900-4910-4920-4930-4940-4950-4960-4970-4980-4990-5000-5010-5020-5030-5040-5050-5060-5070-5080-5090-5100-5110-5120-5130-5140-5150-5160-5170-5180-5190-5200-5210-5220-5230-5240-5250-5260-5270-5280-5290-5300-5310-5320-5330-5340-5350-5360-5370-5380-5390-5400-5410-5420-5430-5440-5450-5460-5470-5480-5490-5500-5510-5520-5530-5540-5550-5560-5570-5580-5590-5600-5610-5620-5630-5640-5650-5660-5670-5680-5690-5700-5710-5720-5730-5740-5750-5760-5770-5780-5790-5800-5810-5820-5830-5840-5850-5860-5870-5880-5890-5900-5910-5920-5930-5940-5950-5960-5970-5980-5990-6000-6010-6020-6030-6040-6050-6060-6070-6080-6090-6100-6110-6120-6130-6140-6150-6160-6170-6180-6190-6200-6210-6220-6230-6240-6250-6260-6270-6280-6290-6300-6310-6320-6330-6340-6350-6360-6370-6380-6390-6400-6410-6420-6430-6440-6450-6460-6470-6480-6490-6500-6510-6520-6530-6540-6550-6560-6570-6580-6590-6600-6610-6620-6630-6640-6650-6660-6670-6680-6690-6700-6710-6720-6730-6740-6750-6760-6770-6780-6790-6800-6810-6820-6830-6840-6850-6860-6870-6880-6890-6900-6910-6920-6930-6940-6950-6960-6970-6980-6990-7000-7010-7020-7030-7040-7050-7060-7070-7080-7090-7100-7110-7120-7130-7140-7150-7160-7170-7180-7190-7200-7210-7220-7230-7240-7250-7260-7270-7280-7290-7300-7310-7320-7330-7340-7350-7360-7370-7380-7390-7400-7410-7420-7430-7440-7450-7460-7470-7480-7490-7500-7510-7520-7530-7540-7550-7560-7570-7580-7590-7600-7610-7620-7630-7640-7650-7660-7670-7680-7690-7700-7710-7720-7730-7740-7750-7760-7770-7780-7790-7800-7810-7820-7830-7840-7850-7860-7870-7880-7890-7900-7910-7920-7930-7940-7950-7960-7970-7980-7990-8000-8010-8020-8030-8040-8050-8060-8070-8080-8090-8100-8110-8120-8130-8140-8150-8160-8170-8180-8190-8200-8210-8220-8230-8240-8250-8260-8270-8280-8290-8300-8310-8320-8330-8340-8350-8360-8370-8380-8390-8400-8410-8420-8430-8440-8450-8460-8470-8480-8490-8500-8510-8520-8530-8540-8550-8560-8570-8580-8590-8600-8610-8620-8630-8640-8650-8660-8670-8680-8690-8700-8710-8720-8730-8740-8750-8760-8770-8780-8790-8800-8810-8820-8830-8840-8850-8860-8870-8880-8890-8900-8910-8920-8930-8940-8950-8960-8970-8980-8990-9000-9010-9020-9030-9040-9050-9060-9070-9080-9090-9100-9110-9120-9130-9140-9150-9160-9170-9180-9190-9200-9210-9220-9230-9240-9250-9260-9270-9280-9290-9300-9310-9320-9330-9340-9350-9360-9370-9380-9390-9400-9410-9420-9430-9440-9450-9460-9470-9480-9490-9500-9510-9520-9530-9540-9550-9560-9570-9580-9590-9600-9610-9620-9630-9640-9650-9660-9670-9680-9690-9700-9710-9720-9730-9740-9750-9760-9770-9780-9790-9800-9810-9820-9830-9840-9850-9860-9870-9880-9890-9900-9910-9920-9930-9940-9950-9960-9970-9980-9990-10000-10010-10020-10030-10040-10050-10060-10070-10080-10090-10100-10110-10120-10130-10140-10150-10160-10170-10180-10190-10200-10210-10220-10230-10240-10250-10260-10270-10280-10290-10300-10310-10320-10330-10340-10350-10360-10370-10380-10390-10400-10410-10420-10430-10440-10450-10460-10470-10480-10490-10500-10510-10520-10530-10540-10550-10560-10570-10580-10590-10600-10610-10620-10630-10640-10650-10660-10670-10680-10690-10700-10710-10720-10730-10740-10750-10760-10770-10780-10790-10800-10810-10820-10830-10840-10850-10860-10870-10880-10890-10900-10910-10920-10930-10940-10950-10960-10970-10980-10990-11000-11010-11020-11030-11040-11050-11060-11070-11080-11090-11100-11110-11120-11130-11140-11150-11160-11170-11180-11190-11200-11210-11220-11230-11240-11250-11260-11270-11280-11290-11300-11310-11320-11330-11340-11350-11360-11370-11380-11390-11400-11410-11420-11430-11440-11450-11460-11470-11480-11490-11500-11510-11520-11530-11540-11550-11560-11570-11580-11590-11600-11610-11620-11630-11640-11650-11660-11670-11680-11690-11700-11710-11720-11730-11740-11750-11760-11770-11780-11790-11800-11810-11820-11830-11840-11850-11860-11870-11880-11890-11900-11910-11920-11930-11940-11950-11960-11970-11980-11990-12000-12010-12020-12030-12040-12050-12060-12070-12080-12090-12100-12110-12120-12130-12140-12150-12160-12170-12180-12190-12200-12210-12220-12230-12240-12250-12260-12270-12280-12290-12300-12310-12320-12330-12340-12350-12360-12370-12380-12390-12400-12410-12420-12430-12440-12450-12460-12470-12480-12490-12500-12510-12520-12530-12540-12550-12560-12570-12580-12590-12600-12610-12620-12630-12640-12650-12660-12670-12680-12690-12700-12710-12720-12730-12740-12750-12760-12770-12780-12790-12800-12810-12820-12830-12840-12850-12860-12870-12880-12890-12900-12910-12920-12930-12940-12950-12960-12970-12980-12990-13000-13010-13020-13030-13040-13050-13060-13070-13080-13090-13100-13110-13120-13130-13140-13150-13160-13170-13180-13190-13200-13210-13220-13230-13240-13250-13260-13270-13280-13290-13300-13310-13320-13330-13340-13350-13360-13370-13380-13390-13400-13410-13420-13430-13440-13450-13460-13470-13480-13490-13500-13510-13520-13530-13540-13550-13560-13570-13580-13590-13600-13610-13620-13630-13640-13650-13660-13670-13680-13690-13700-13710-13720-13730-13740-13750-13760-13770-13780-13790-13800-13810-13820-13830-13840-13850-13860-13870-13880-13890-13900-13910-13920-13930-13940-13950-13960-13970-13980-13990-14000-14010-14020-14030-14040-14050-14060-14070-14080-14090-14100-14110-14120-14130-14140-14150-14160-14170-14180-14190-14200-14210-14220-14230-14240-14250-14260-14270-14280-14290-14300-14310-14320-14330-14340-14350-14360-14370-14380-14390-14400-14410-14420-14430-14440-14450-14460-14470-14480-14490-14500-14510-14520-14530-14540-14550-14560-14570-14580-14590-14600-14610-14620-14630-14640-14650-14660-14670-14680-14690-14700-14710-14720-14730-14740-14750-14760-14770-14780-14790-14800-14810-14820-14830-14840-14850-14860-14870-14880-14890-14900-14910-14920-14930-14940-14950-14960-14970-14980-14990-15000-15010-15020-15030-15040-15050-15060-15070-15080-15090-15100-15110-15120-15130-15140-15150-15160-15170-15180-15190-15200-15210-15220-15230-15240-15250-15260-15270-15280-15290-15300-15310-15320-15330-15340-15350-15360-15370-15380-15390-15400-15410-15420-15430-15440-15450-15460-15470-15480-15490-15500-15510-15520-15530-15540-15550-15560-15570-15580-15590-15600-15610-15620-15630-15640-15650-15660-15670-15680-15690-15700-15710-15720-15730-15740-15750-15760-15770-15780-15790-15800-15810-15820-15830-15840-15850-15860-15870-15880-15890-15900-15910-15920-15930-15940-15950-15960-15970-15980-15990-16000-16010-16020-16030-16040-16050-16060-16070-16080-16090-16100-16110-16120-16130-16140-16150-16160-16170-16180-16190-16200-16210-16220-16230-16240-16250-16260-16270-16280-16290-16300-16310-16320-16330-16340-16350-16360-16370-16380-16390-16400-16410-16420-16430-16440-16450-16460-16470-16480-16490-16500-16510-16520-16530-16540-16550-16560-16570-16580-16590-16600-16610-16620-16630-16640-16650-16660-16670-16680-16690-16700-16710-16720-16730-16740-16750-16760-16770-16780-16790-16800-16810-16820-16830-16840-16850-16860-16870-16880-16890-16900-16910-16920-16930-16940-16950-16960-16970-16980-16990-17000-17010-17020-17030-17040-17050-17060-17070-17080-17090-17100-17110-17120-17130-17140-17150-17160-17170-17180-17190-17200-17210-17220-17230-17240-17250-17260-17270-17280-17290-17300-17310-17320-17330-17340-17350-17360-17370-17380-17390-17400-17410-17420-17430-17440-17450-17460-17470-17480-17490-17500-17510-17520-17530-17540-17550-17560-17570-17580-17590-17600-17610-17620-17630-17640-17650-17660-17670-17680-17690-17700-17710-17720-17730-17740-17750-17760-17770-17780-17790-17800-17810-17820-17830-17840-17850-17860-17870-17880-17890-17900-17910-17920-17930-17940-17950-17960-17970-17980-17990-18000-18010-18020-18030-18040-18050-18060-18070-18080-18090-18100-18110-18120-18130-18140-18150-18160-18170-18180-18190-18200-18210-18220-18230-18240-18250-18260-18270-18280-18290-18300-18310-18320-18330-18340-18350-18360-18370-18380-18390-18400-18410-18420-18430-18440-18450-18460-18470-18480-18490-18500-18510-18520-18530-18540-18550-18560-18570-18580-18590-18600-18610-18620-18630-18640-18650-18660-18670-18680-18690-18700-18710-18720-18730-18740-18750-18760-18770-18780-18790-18800-18810-18820-18830-18840-18850-18860-18870-18880-18890-18900-18910-18920-18930-18940-18950-18960-18970-18980-18990-19000-19010-19020-19030-19040-19050-19060-19070-19080-19090-19100-19110-19120-19130-19140-19150-19160-19170-19180-19190-19200-19210-19220-19230-19240-19250-19260-19270-19280-19290-19300-19310-19320-19330-19340-19350-19360-19370-19380-19390-19400-19410-19420-19430-19440-19450-19460-19470-19480-19490-19500-19510-19520-19530-19540-19550-19560-19570-19580-19590-19600-19610-19620-19630-19640-19650-19660-19670-19680-19690-19700-19710-19720-19730-19740-19750-19760-19770-19780-19790-19800-19810-19820-19830-19840-19850-19860-19870-19880-19890-19900-19910-19920-19930-19940-19950-19960-19970-19980-19990-20000-20010-20020-20030-20040-20050-20060-20070-20080-20090-20100-20110-20120-20130-20140-20150-20160-20170-20180-20190-20200-20210-20220-20230-20240-20250-20260-20270-20280-20290-20300-20310-20320-20330-20340-20350-20360-20370-20380-20390-20400-20410-20420-20430-20440-20450-20460-20470-20480-20490-20500-20510-20520-20530-20540-20550-20560-20570-20580-20590-20600-20610-20620-20630-20640-20650-20660-20670-20680-20690-20700-20710-20720-20730-20740-20750-20760-





## AVIATION WEEK, July 2, 1993

DC-3 ... DC-4 ... DC-6 ... DC-7

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